TRANSACTIONS

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TRANSACTIONS.

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NEW ZEALAND INSTITUTE,

1914.

ART. I.—*A Revised List of the Norfolk Island Flora, with some Notes on the Species.*

By ROBERT M. LAING, M.A., B.Sc.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1914.*]

INTRODUCTORY.

IN January and February, 1912, I paid a visit of five weeks to Norfolk Island. During that time I collected and examined the indigenous plants, visiting all parts of the island in search of them. Several hours were also spent on the outlying Phillip Island, three or four miles to the south. I was unable to make a complete examination of this interesting rock, but I had time to reach its highest point. Since my return from the island I have had the opportunity of looking through the collection of the Norfolk Island plants in the herbarium of the Botanic Gardens, Sydney. I have also received many additional specimens from my father, Mr. W. Laing, resident on the island, and I have seen a collection of specimens made on the island by Mr. H. C. Quintall for Mr. W. R. B. Oliver. From this material I propose to draw up a revised list of the species, to add some notes on the lesser-known forms, and to make some remarks on the present condition of the vegetation and on the difficulties in ascertaining the original contents of the flora.

Before doing so, however, I should like to thank the following gentlemen for much assistance kindly rendered: Mr. Gerald Allen, of Norfolk Island, who gave me much aid in reaching various parts of the island; Mr. J. H. Maiden, Government Botanist of New South Wales, for the identification of some species and much other assistance; Mr. D. Petrie, of Auckland, for much help in the identification of the grasses; Mr. Cheeseman and Dr. Cockayne, F.R.S.; and, lastly, Mr. W. R. B. Oliver, whose investigation of the Kermadec and Lord Howe Island plants has served to make the florulas of these subtropical islands much better known.

I do not propose in this paper to discuss the relationships of the flora. Much work has been done, and is being done, in this direction by many writers. Norfolk Island has undoubtedly to be considered firstly in connection with the Kermadecs and Lord Howe Island, and then in relation to New Zealand and Australia. I have, therefore, shown as far as I could the external distribution of all species occurring on Norfolk Island. This will provide other investigators with the necessary data for determining the origin of the florula.

Present Condition of the Vegetation.

At present Norfolk Island is a mass of weeds from summit to base. Even the bush, or "stick" as it is called by the Norfolkers, is full of introduced plants; and in the open country they are far more common than the native species. There is probably not an acre of open land on the island—perhaps not a quarter of an acre—which does not contain the introduced *Solanum auriculatum* in quantity. *Solanum sodomaeum* and *Cassia levigata* are almost as common. There is at present not sufficient labour on the island to cope with these pests; however, one at least of them (*S. sodomaeum*) has, I think, reached its natural limits of increase, and is not now so plentiful as it was when I paid a short visit to the island in January, 1901. Other serious pests are *Lantana camara*, *Datura stramonium*, and *Salvia pseudococcinea*. *Ricinus communis* and *Phytolacca octandra* are also fairly abundant. Lemon-trees and occasional other species of *Citrus* are found nearly all through the bush, and there are large groves of guavas everywhere. Stock are allowed to run wherever there are no fences, and this helps to destroy the undergrowth. However, at Hundred Acres there is a reserve of some 50 acres which has been enclosed for several years. In another four or five years it will be impenetrable to man without a bill-hook. It shows how quickly the bush would reclothe the island if stock were removed. Here the weeds are fewer than in other parts of the island, and, apart from occasional plants of *Citrus*, *Cassia*, and *Solanum*, the bush is chiefly of indigenous growth. This, however, cannot be taken as representing the primeval forest, for doubtless this area had been run through by stock for fifty years before its enclosure, and also had been searched for timber. Most, though not all, of its present covering is second growth. Indeed, in the convict days about four-fifths of the island was under cultivation. This, where not covered with weeds or used as orchard, is now pasture land, grassed with *Cynodon dactylon*, a grass that has probably been introduced. *Paspalum dilatatum* and *Stenotaphrum americanum* are also sometimes sown.

These grasses provide pasture for a number of cattle, horses, and a few sheep. In dry seasons the island is altogether overstocked, and the stock are allowed to roam freely over it in search of fodder. It is true that in addition to the reserve at Hundred Acres already mentioned there are several other bush-enclosures, but these are at times open to stock, and wherever the cattle go the smaller indigenous plants disappear, young bush trees are destroyed, and weeds become abundant. Indeed, few of the bush plants seem to be able to survive under these conditions except *Lagunaria Patersoni*, *Araucaria excelsa*, and one or two other trees and creepers. It is now, therefore, difficult for the botanist to distinguish between indigenous and introduced plants. The nature of these difficulties will be discussed more fully presently.

Our Knowledge of the Flora.

Fortunately for us, however, the plants of the island were fully collected in 1804–5 by Ferdinand Bauer, the flower-painter. His collections were described by a well-known botanist, Stephen Endlicher, of Vienna, in 1833. The descriptions in most cases are so good and detailed that for systematic purposes little needs to be added to them at the present day. Just a century later than Bauer's visit, in 1904, there was published the comprehensive and judicial paper on the flora of Norfolk Island, by Mr. J. H. Maiden, Director of the Botanic Gardens, Sydney. To Endlicher and Maiden's Floras, therefore, I am particularly indebted in this paper, and without them this could

not have been written. Maiden paid a short visit to the island in 1902, and in the century that had elapsed between his visit and Bauer's various collectors had been there; but of these only one need be mentioned here—Allan Cunningham, a former Director of the Sydney Gardens. The additions made by Cunningham to Endlicher's list were published after his death by R. Heward in Hooker's *London Journal of Botany*, i, p. 107. This, unfortunately, I have not been able to see. In addition, large numbers of plants have been sent to Sydney and Melbourne by residents on the island. Unfortunately, such collections have contained many introductions. The collector, though with every good intention, has been unable to distinguish between naturalized and indigenous species. These species have been accepted by Australian botanists, in some cases too readily. Maiden has been more critical, and has cut out some of them from his list; but it seems to me that there are still more, particularly among the ferns and grasses, which have to be rejected. In addition to introduced species, a few plants that have been listed have not been found on the island at all, but have been inserted through some error as to their habitat. These are plants belonging chiefly to Australia, Lord Howe Island, and in one or two cases to the New Hebrides.

Though the botanist who does his own collecting on the island has much better opportunities of distinguishing between naturalized and introduced species, yet, owing to the conditions, it is frequently impossible even for him to form a definite opinion in a given case. The chief reasons for this are (1) the omnipresence of weeds already mentioned, and (2) the fact that many of the introduced species are just those that might be expected to occur indigenously. This is especially true of Australian plants. Constant communication with Australia for more than a century has undoubtedly led to the introduction not only of a large number of Australian plants, but also of an unusual abundance of subtropical weeds. The mere finding of a plant on the island can, therefore, no longer be regarded as a proof that it is an indigene, and other tests have to be applied; yet even with these it is often impossible to arrive at any certainty as to whether a plant is native or foreign.

Indeed, the following consideration seems to show clearly that among recent additions to the flora of the island there have been included some importations. Maiden gives a list of forty-six phanerogams new to the island, but not one of these is endemic. Now, in Endlicher's list of about a hundred phanerogams about one-third are endemic. It is very improbable that Bauer should have discovered all the endemic species and yet have neglected forty-six indigenous but non-endemic species. This improbability is immensely increased when it is remembered that many of the newly added species are well-known plants elsewhere and are abundant on the island, whereas some of the endemic species recorded by Bauer are now very rare, and probably always have been rare on the island. One would certainly have expected to find in the forty-six species added by Maiden the same percentage of endemic species as in Endlicher's list. The total absence of local forms in the list is, to my mind, very strong evidence that at least a fair proportion of the added species are naturalized and not truly indigenous.

Presumptive evidence to the same effect may also be derived from this further consideration, though I do not wish to place too much weight upon it. It is generally recognized—*e.g.*, by Hemsley, Cockayne, and others—that under similar conditions the number of species upon an island will

be roughly proportionate to its area. Now, the Kermadec Islands have a similar area and height to Norfolk Island, and do not differ very much from it in latitude, and consequently they may be expected to contain a similar number of species; yet for Norfolk Island Maiden gives a list of 163 phanerogams and fifty-three ferns (including Lycopods), a total of 216, whereas for the Kermadecs W. R. B. Oliver gives a total of only 115 species, of which thirty-nine are ferns. It would seem, therefore, that either the Norfolk Island list is in excess or the Kermadec list in defect, or that some special cause has been at work to increase the number of species in one case and diminish it in the other. I have little doubt myself that the first of these reasons is the true one. On Lord Howe Island there are also over two hundred species recorded; but the surface of that island is much more varied than that of Norfolk Island, and it has mountains of upwards of 3,000 ft. upon it. One would, therefore, expect to find fewer species upon Norfolk Island than upon it.

Tests for Distinguishing Indigenous Species.

One may feel comparatively sure that the list of Norfolk Island species has been stuffed with aliens; but when it comes to examining the title of any particular species to appear, difficulties are in most cases encountered. Two questions have to be asked and answered before a decision can be made: (1) Has the plant been found growing on the island? (2) if growing on the island, is it indigenous or introduced?

There are undoubtedly a few plants on the list which have not been found growing on the island. They have been introduced owing to the mixing of specimens in herbaria from different habitats, or to some other form of carelessness, or accident. In dealing with this question I have adopted the following rule: Plants recorded only by botanists who have not visited the island, and without a collector's name, are to be regarded with suspicion. Many of the species introduced into the list by the late Professor R. Tate come under this category. In deciding whether a plant has been found on the island I have also received considerable assistance from the examination of the fine collection in the herbarium at Sydney Gardens. This collection is by no means complete, some undoubted inhabitants not being present in it; but the absence of a suspected species from this collection adds a further suspicion to the record. I know, of course, from experience how dangerous it is to conclude from negative evidence that a plant has not been found in a given place, and evidence of this character alone should rarely be relied upon. Some of the species found by Bauer do not seem to have been found recently, but they are not, therefore, in any way suspect, as his herbarium is still in existence, and his records are most reliable. Mr. Maiden has endeavoured in his list to cut out doubtful records, but unfortunately does not always indicate those plants which he himself found growing on the island. However, the number of species involved in the doubtful records are few as compared with those which undoubtedly do occur on the island but are doubtfully indigenous.

I now give briefly those rules which I have followed in determining if a species occurring on the island is to be regarded as a native to it.

(1.) All plants recorded by Endlicher, with two or three exceptions, are to be regarded as indigenous. Bauer spent eight months on the island shortly after its settlement, and before the vegetation had been ruined. He was a careful observer, and adds notes in one or two cases where he considers a species doubtfully indigenous.

(2.) Plants now common throughout the island but not recorded by Endlicher are probably introduced. It is quite clear that Bauer made a thorough collection of the plants of the island. No endemic species, except perhaps *Clematis cocculifolia*, has been discovered since his time. The significance of this fact has not been sufficiently recognized by subsequent collectors. Bauer certainly overlooked a few species, the most conspicuous of which are *Melicytus ramiflorus* and *Dodonaea viscosa*; the former of these, however, is not abundant, and the latter grows in an area inaccessible in his time. It may be that in some cases indigenous species once rare on the island have, as a result of changed conditions, become abundant; but I have no specific evidence of this in any one case, and feel convinced that the absence of any plant now common from Endlicher's list is strong *prima facie* evidence of its introduction subsequent to Bauer's visit.

(3.) New Zealand and Australian plants only found subsequently to Bauer's visit are, even if not common on the island, to be considered doubtful, unless the conditions of their discovery clearly show them to be native. Early whalers frequently brought plants to the island from neighbouring lands. This, of course, is especially true of vegetables; thus, a kumara —"Sunday Island kumara"—largely cultivated on the island is said to have been brought from the Kermadecs; a certain variety of taro probably came from the New Hebrides. Since the earliest convict days continual exchanges of plants and seeds have been made between the island and Sydney.

(4.) Plants found only on the ruderal areas, on ground that has been cultivated or in the neighbourhood of settlement, must also be considered as probable recent importations.

(5.) When a species known as an introduction in New Zealand and Australia is found on Norfolk Island, it is probably also an introduction in the last-mentioned habitat.

(6.) It is clear from early accounts of the vegetation (M., pp. 774 and 775) that when discovered the island, except for the shore-line, was originally totally covered with forest—*e.g.*, "without a single acre of clear land" (Lieutenant King); "For about 200 yards from the shore the ground is covered so thick with shrubs and plants as hardly to be penetrated inland" (Captain Cook). One would therefore expect the flora to consist exclusively or almost exclusively of coastal and forest plants. Hence plants of the prairie, pasture land, moor, or open country generally will be absent. Such plants, therefore, as *Viola betonicaefolia*, *Malvastrum tricuspidatum*, *Pelargonium australe*, *Sida rhombifolia*, may be regarded as doubtfully indigenous at least.

These are the chief tests I have used in determining whether a species is native or alien. The above rules are, of course, not intended to be hard and fast, they must rather be regarded as elastic; but the considerations given above will enable future observers to judge of my reasons for retaining a plant or excluding it from this list.

I think it very unlikely that further additions of importance will be made to the list of indigenous species. I had good opportunities of visiting every part of the island, and if I did not observe any species it can scarcely have been common. Still, there may be a few that I have failed to collect or to identify for various reasons: (*a*.) In several cases the specimens secured were too incomplete or immature for identification. (*b*.) Some nooks and corners of the island escaped search. A further examination of Phillip Island is undoubtedly required. At the foot of the cliffs and on the rock-

faces there are species to be obtained not collected by me. It is very unlikely, however, that there will be any among them not recorded from Norfolk Island itself. (*c.*) It was a season of drought—ferns, grasses, and other plants were dried up. For this reason, some species may have been overlooked. (*d.*) Some plants previously recorded are probably now extinct. (*e.*) Some seasonal plants were perhaps not observed. I cannot think, however, that much remains to be added to the list. On the other hand, my list doubtless still contains some introduced species: the difficulty lies in knowing which to eliminate.

Plant Associations.

It will be clear from what has already been said that it is now impossible to give anything like an adequate account of the primeval condition of the vegetation, or of its original plant associations. I have hitherto been unable to get statistics of the rainfall and weather-conditions, though I believe they have been to some extent recorded. The rainfall is, I think, about 45 in. per year, but it is often very unevenly distributed. Summer and autumn droughts are not infrequent. When discovered by Captain Cook the island was in most places covered with an almost impenetrable forest—undoubtedly a mesophytic rain forest. The remnants of this are still to be found, but in a very altered condition. Here and there the forest may have consisted chiefly of a comparatively open formation of *Araucaria excelsa*, as still at Bamboras, where nothing else is now to be found. Here on the forest floor the roots from an interlacing network, spreading on or near the surface, and the ground is otherwise bare. Undoubtedly, however, the chief portion of the forest contained, as in New Zealand, a considerable number of species of trees, interlaced by huge lianes *e.g.*, *Capparis*, *Jasminum*, *Tylophora*, &c.—which practically stopped all progress on foot. There is little sign of xerophyly in the vegetation, though such plants as *Wickstroemia australis*, *Exocarpus phyllanthoides*, *Cordyline Baueri*, and *Phormium tenax* may be regarded as exceptions to this rule; and, on the other hand, the large tender membranous leaves of the hygrophytic forest are also generally absent, though, again, in *Piper excelsum* var. *psittacorum*, *Pisonia Brunoniana*, and one or two other species the leaves approach this type. Taken as a whole, however, the forest would probably, in its adaptations to moisture, be not at all unlike the mesophytic rain forests of Auckland Province. As there is none of the untouched primitive forest on the island, this is, of course, to some extent only a surmise.

Probably the only portion of the vegetation that remains somewhat in its original condition is that of the coastal rocks and cliffs. The coastal species show little endemism, and are mostly widely distributed plants, whose seeds are perhaps carried by ocean birds and winds, though some species are probably of recent and artificial introduction. *Wedelia biflora* often forms a matted trailing mass on the sea-banks, to the exclusion of other vegetation. *Ipomoea palmata* and *Samolus repens* var. *stricta* also form patches on the seashore. *Lobelia anceps* and *Mesembryanthemum aequilaterale* hang from the coastal cliffs. *Tetragonia expansa*, *T. trigyna*, *Asplenium difforme*, and *Canavallia obtusifolia* also occur, though less abundantly. *Oxalis corniculata* var. *reptans* is common on the tops of the cliffs. More rarely, *Capparis*, dwarfed and scrambling, is found on or near the shore. Maiden got *Ipomoea biloba* and *Calystegia Soldanella*. Not far inland *Scirpus nodosus* and *Mariscus haematodes* appear. In more or less inaccessible places *Coprosma Baueri* is occasionally found. Probably

all these species formed portion of the original vegetation of the island, which still exists much as it did before the island was inhabited. This portion of the flora is quite what we might have expected to have found in such a situation, and, as most of the species occur widely, they throw no light on the origin of the remainder.

The best account of the general characters of the original vegetation is to be found in Backhouse's "Narrative of a Visit to the Australian Colonies" (London, 1843). Maiden quotes most of Backhouse's descriptions in his paper on the flora.

PHILLIP ISLAND.

No account of the vegetation of Norfolk Island would be complete without some reference to the remarkable story of the vegetation of this outlying rock. According to Governor King (quoted by Maiden, p. 183), the island was in 1788 sparsely wooded, and, where not wooded, covered with a "thick entangled kind of reed." Allan Cunningham, who visited the island later, and was, indeed, marooned there by the convicts for a time, found in the interior "some deep hollows," "in parts densely wooded with small trees, and an underwood chiefly of the thorny caper bush (*Busbeckia nobilis*)." Of this once comparatively plentiful vegetation nothing is now left but a few scattered trees. In most parts the island consists of red, yellow, brown, volcanic tuff and disintegrated volcanic rocks of all hues. The vegetation is obviously becoming yearly more sparse, and the island is fast becoming a complete desert. Most of the trees had been leafless shortly before I saw them, but, as the result of some earlier rains, young shoots and leaves had broken out from the main branches. There was practically no soil; scarcely a seedling was to be seen anywhere, and the rain-water had formed deep trenches in the bare volcanic "clay." Not a blade of grass was to be seen except in the clefts of the rocks near the beach. The explanation given of the disappearance of the vegetation is that originally pigs were put upon the island. These destroyed all the undergrowth, grubbed among the roots, and so helped to loosen the soil, which was then washed away by the rain. Subsequently rabbits were introduced, and multiplied until they had eaten every green leaf within reach, and gnawed the bark of most of the trees. They added to the havoc commenced by the pigs, and the destruction of the soil was practically completed by them. Rumour even states that food became so scarce that the rabbits commenced to prey upon each other. There are no rabbits on Norfolk Island itself. The rabbits, however, still exist on Phillip Island, and I saw one or two which had been shot there. They were in moderately good condition. It may be that this is the correct explanation of the desiccation and destruction of the vegetation on the island; at least, I could find no other. Of course, a number of years of drought would also furnish a fairly adequate explanation. At any rate, unless conditions alter a great deal the island will shortly be completely desert, except for a few plants growing in the clefts of the rocks and at the foot of the cliffs. I saw no big trees on the island. The largest were one or two dead *Araucarias* lying on the ground. The washing-away of the soil about their roots had apparently caused their fall.

Undoubtedly the presence of immense numbers of sea-birds also tends to the destruction of the vegetation.* Red-tailed tropic-birds, gannets, wideawakes, and other birds were nesting on the island at the time of my visit.

* *Vide* Cockayne, "Subantarctic Islands of New Zealand," p. 233.

Some of the few remaining trees were full of sea-birds, and their branches almost white with their dung. These birds no doubt assist considerably in the destruction of the vegetation, but they cannot account for its present rapid disappearance.

Phillip Island contained three endemic species: *Hibiscus insularis* Endl., *Streblorrhiza speciosa*, and *Triticum Kingianum*. Of these, I obtained the first and the third. The second is almost certainly extinct. Maiden adds a fourth species, but this (*Solanum Bauerianum*) occurs also on Lord Howe. To save space I have not drawn up a separate list of species for this island. They will be found included in the main list.

A description of the physiographic features of Norfolk Island by myself, and the microscopic characters of the rocks by R. Speight, M.A., M.Sc., will be found in the Transactions of the New Zealand Institute for 1913.

Origin of Flora.

As already stated, I do not intend to deal with the origin of the flora An investigation into it can only be taken in conjunction with a discussion of the distribution of the fauna. A rough statement, however, may be made of the results obtained as shown by this paper.

An analysis of the species of phanerogams on the island gives the following results: 41 per cent. are found outside Australasia, and may be regarded as representing a Malayo-Australasian element; 29 per cent. are endemic; 14 per cent. are Australasian; 7 per cent. are found only in Norfolk Island and Australia; of the remaining 9 per cent., approximately 5 per cent. are confined to Norfolk Island and New Zealand, and the remainder are found either in the Kermadecs, or Lord Howe, or in all three groups. Now, such a bare analysis is most misleading if used as a platform for rigid conclusions. Perhaps all that can be concluded from it is that the basis of the Norfolk Island flora is an element widely distributed in the eastern subtropical South Pacific. The remainder is Australasian.

A Short Bibliography.

This list includes only the chief books and articles referred to by me. For a more complete bibliography Maiden's work should be consulted.

1. "Prodromus Florae Norfolkicae." Endlicher, Vienna, 1833.
2. "Hooker's London Journal of Botany," vol. i, 1842. "Biographical Sketch of the late Allan Cunningham." (This includes a list of plants discovered by Cunningham on the island, but not appearing in Endlicher.) (I have not seen this.—R. M. L.)
3. "Narrative of a Visit to the Australian Colonies." By J. Backhouse, London, 1843. (An excellent description of the general facies of the vegetation in the early convict days is given.)
4. "Flora Australiensis." Bentham, 1863. (This contains many records of Norfolk Island species.)
5. "On the Geographic Relations of the Floras of Norfolk and Lord Howe Islands." By R. Tate. "Macleay Memorial Volume," Sydney. (This gives a somewhat unreliable list of the species of both islands.)
6. "The Flora of Norfolk Island," part i. By J. H. Maiden, Government Botanist of New South Wales. (Proceedings of the Linnean Society of New South Wales, 1903.)
7. "Manual of the New Zealand Flora." By T. F. Cheeseman, Wellington, 1906.
8. "Vegetation of the Kermadec Islands." By W. R. B. Oliver, Trans. N.Z. Inst., vol. 42, p. 118, 1910.

LIST OF SPECIES OF FLOWERING-PLANTS AND FERNS INDIGENOUS TO NORFOLK ISLAND.†

SOME ABBREVIATIONS.

* Not found by me.
E. Endlicher's list of Norfolk Island species.
M. Maiden's list of Norfolk Island species.
T.N.Z.I. "Transactions of the New Zealand Institute."
Cheesem. Cheeseman's "Manual of the New Zealand Flora."
Benth. Bentham's "Flora Australiensis."

PTERIDOPHYTA.

FILICINAE.

The late Dr. Metcalf, whose knowledge of the ferns of Norfolk was unique, assured me that he was satisfied that the number of species to be found on the island was little over thirty. Maiden records fifty-two, but there is no first-hand evidence that some of these have been collected on the island by any botanist. On this ground, the ferns numbered as follows in Maiden's list are here omitted: 1, 8, 22, 42, 47, 49. Of these, (22) *Pteris marginata* Borz. is recorded by Müller as having been found by Mr. I. Robinson on the island; (8) *Polypodium acrostichioides* Forst. and (42) *Aspidium tenerum* Spreng. are recorded by Müller as having been collected by Carne; (47) *Lindsaya linearis* Sw. and (49) *Dennstaedtia* (*Dicksonia*) *davallioides* T. Moore are recorded in Benth. without any collector's name. The Norfolkers grow many foreign species in their "bush houses," and it would be quite easy for some of these to get into lists drawn up by botanists who have not visited the island. (1) *Hymenophyllum multifidum* appears first in Tate's list; but no collector's name is attached to it.

HYMENOPHYLLACEAE.

1. **Trichomanes Bauerianum** Endl., E. 50. (= *T. apiifolium* Presl., M. 2.)
   Abundant on the sides of rocks in darker bush creeks.
   Lord Howe, New Caledonia, Australia, Malaya, Polynesia.

2. **Trichomanes humile** Forst., E. 49, M. 3.
   In moist places in the darker forests.
   Kermadecs, New Zealand, Australia, and adjacent tropics.

CYATHEACEAE.

Cyathea medullaris Forst., appears E. 47, but is not in Bauer's herbarium, and has not been found in Norfolk Island by any subsequent botanist. (*Vide* M., p. 737, and under "*Alsophila robusta*," below.)

3. **Alsophila excelsa** R. Br., E. 48, M. 50.
   Not common on the island, and much confused with the following, which is perhaps more abundant.

4. **Alsophila robusta** C. Moore var. **norfolkiana** Laing var. nov.
   Costis costulisque parce muricatis, fulve tomentosis et paucis squamis linearibus conspersis.
   The variety everywhere common on Norfolk Island. The typical form on Lord Howe; related also to *A. australis* of Australia.
   I had confused this with the previous species until Mr. Oliver pointed out to me that two species occurred on the island, and sent me a specimen

† A collection of Norfolk Island plants has been presented by me to the Canterbury Museum.

of each. This differs from *A. robusta* of Lord Howe in the less muricated costae and costules, and in the presence of a larger amount of tomentum and in the absence of scales. At the same time, until I have seen more specimens of this and *A. robusta* I do not feel quite satisfied about the distinctions. Doubtless there has been some confusion between them in the past. This is possibly the plant referred to by Endlicher and Backhouse as *Cyathea medullaris;* subsequent observers have either included this with *A. excelsa*, or referred it to *A. australis*, which it somewhat resembles (Bentham, Tate). Without access to type collections it would be difficult to determine the exact synonymy of this and *A. excelsa*.

The two species are undoubtedly quite distinct. In *A. robusta* var. *norfolkiana* the terminal pinnules are 10–12 mm. long, 3–4 mm. wide, concave on the upper margin and convex on the lower, entire or crenulate and obtuse. The sori are usually found from base to the top of the pinnule, and the fertile fronds are generally incurved at the margins. Sometimes, however, the sori do not extend beyond the middle of the pinnule, which is much less membranous than in *A. excelsa*.

In the latter the ultimate pinnules are 8–10 mm. long, 3–4 mm. wide, less concave on the upper margin than in the previous species. Unfortunately, I have at present only one specimen. In it the sori do not extend along more than two-thirds of the frond, number usually 4–6 pairs, the margin is regularly serrate on both surfaces, and the tip is acute. The midrib of the secondary pinnules is much more markedly paleaceous than in the preceding species. Mr. Maiden tells me that *A. excelsa* and *A. australis* are thus distinguished :—

Rhachis more or less stramineous, and stalk of frond completely deciduous, leaving a smooth scar on stem .. .. *A. excelsa.*
Rhachis not stramineous, base of stalk persistent, leaving a rough trunk† .. *A. australis.*

POLYPODIACEAE.

5. **Dryopteris punctata** (Thbg.) C. Chr. (= *Phegopteris punctata* Thbg., M. 11 and 44 ; *Polypodium rugulosum* Labill., E. 20.)

Australia, New Zealand, and widely in tropical and subtropical regions.

6. **Dryopteris parasitica** (L.) O. Ktze. (= *Aspidium parasiticum* Mett., M. 38.)

Not uncommon by bush creeks and swamps.

Kermadecs, Lord Howe, New Zealand, Australia, and widely in warmer regions.

7. **Dryopteris setigera** (Bl.) O. Ktze. (= *Aspidium setigera* Bl., M. 43.)

Recorded by Müller. The only specimen seen by me was collected by Mr. H. C. Quintall, and sent me by Mr. W. R. B. Oliver; perhaps introduced.

Kermadecs, Australia, Polynesia, Malaya.

Dryopteris decomposita (R. Br.) O. Ktze. (= (?) *Nephrodium microsorum* Endl., E. 24 ; *N. calanthum*, E. 25 ; and also *Aspidium decompositum*, M. 41.)

The evidence for the existence of this fern on the island is quite unsatisfactory. A. Cunn. (quoted M. 736) considered *Nephrodium microsorum* and

† For the distinction between *A. australis* and *A. robusta*, *vide* the Rev. W. Watts, Proc. Linn. Soc. N.S.W., vol. 39, p. 261 (1914).

N. calanthum as identical with the following fern of this list—*Polystichum aristatum*. Maiden considers these as more probably synonymous with *Aspidium decompositum* Spreng.; but apparently did not himself find it on the island, nor did I. When so much is doubtful, and the fern has not been recently found, it should, I think, be excluded from the list.

8. **Polystichum aristatum** (Sw.) Pr. (= *Aspidium aristatum* Sw., E. 23, M. 39.) (See also above.)

Everywhere abundant in the drier bush.

Kermadecs, Australia, New Zealand, and widely in the Southern Hemisphere.

9. **Polystichum adiantiforme** (Forst.) J. Sm. (= *Aspidium coriaceum* Sw., E. 22; *A. capense* Willd., M. 40.)

Australia, New Zealand, and widely throughout the Southern Hemisphere.

10. **Arthopteris tenella** (Forst.) J. Sm. (= *Polypodium tenellum* Forst., E. 18, M. 5.)

Climbing on trunks of trees.

Lord Howe, Australia, New Zealand, New Caledonia.

11. **Nephrolepis cordifolia** (L.) Pr., M. 46.

Pop Rock and rocky ledges.

Kermadecs, Lord Howe, New Caledonia, Australia, New Zealand, and widely in the Southern Hemisphere.

(Called on the island "Pop Rock fern.")

12. **Davallia pyxidata** Cav., M. 48.

Mount Pitt.

Australia.

13. **Athyrium umbrosum** (Ait.) Pr., M. 36. (= *Allantodia australis* R. Br., E. 31; *Asplenium assimile* Endl., E. 30.)

In the denser bush, Mount Pitt.

Australia, New Zealand, and widely in warmer regions of the Eastern Hemisphere.

Athyrium brevisorum Wall., M. 37, is also recorded by Maiden from Norfolk Island, but as this is a fern of northern India there is probably some mistake in the matter, and I hesitate to introduce it into the list.

14. **Diplazium japonicum** (Thbg.) Bedd., M. 35.

Mount Pitt; not common.

Kermadecs, Australia, New Zealand, Polynesia, and tropical Asia.

15. **Asplenium nidus** L., E. 26, M. 30.

Everywhere common in the damper bush.

Lord Howe, New Caledonia, Australia, Asia, Polynesia, Africa.

15A. **Asplenium Robinsonii** F. v. M., M. 31.

Norfolk Island; very rare.

I retain this with much hesitation. It seems to me that this is probably only an occasionally occurring crested and incised sport or mutant from the previous. I did not myself see it growing wild. The only living speci-

mens I saw were in cultivation on the island; and in one case apparently on the same plant I saw normal fronds of *A. nidus* growing, together with the abnormal fronds of *A. Robinsonii*. However, it is not quite extinct. The late Mr. Robinson sent away all the plants he could find of it. Mrs. W. Laing has, however, recently (1914) found young specimens on different parts of the island. It is a much less luxuriant plant than *A. nidus*, and its fronds do not appear to reach 2 ft. in height. The fronds are always petiolate and usually crested and incised but occasionally entire. As in *A. nidus*, the sori are usually confined to the upper part of the frond, and, though sometimes not reaching to the midrib, they do not differ from *A. nidus* in this respect. Thus the reproductive distinctions relied upon by Baron von Müller† scarcely seem to exist. The distinctions in form, size, incision, and lobing of the frond are undoubtedly sufficient to form a good species, did one not know that such variations occur not unfrequently as recognized sports in similar ferns. Thus the forms of *A. nidus* and *A. Robinsonii* are exactly paralleled by the mutations of the hart's tongue fern, *Scolopendrium vulgare*.‡

The less luxuriant habit and the constant petiolation are perhaps characters of more importance than the varying incision and lobing of the leaves, and may justify the retention of this as a distinct species.

16. Asplenium difforme R. Br., E. 28. (= *A. obtusatum* Forst. var. *difforme*, M. 32.)

Australia.

I cannot agree that this is only a form of *A. obtusatum*, in spite of the weight of opinion against me—*e.g.*, Hooker and Baker, Maiden, Christiansen. The plant grows abundantly on the coastal rocks both of Norfolk Island and Phillip Island, and shows great variety in the division of its fronds; but at no time is it similar to the common form of *A. obtusatum* as met with in New Zealand. Indeed, it approaches closely at times to *A lucidum* var. *Lyallii*. Further, I cannot bear out the statement of Backhouse (3), to whom we are indebted for an excellent general description of the character of the flora before it was overrun by weeds. He, speaking of this fern, states that "at a short distance from the shore its leaves become more divided, and in the woods in the interior of the island they are separated into such narrow segments that the lines of fructification are thrown upon the margin." The plant only grows on rocky shores, and does not occur inland, and the fronds on one rootstock are often polymorphous. Three types of pinnae may perhaps be distinguished, but intermediates are abundant.

(*a.*) The pinnae are 5–8 cm. long, 12–15 mm. broad, lanceolate to oblong in outline, crenate-dentate at the top, pinnatifid towards the middle and pinnate at the base; thus much resembling *A. lucidum* var. *Lyallii*.

(*b.*) The pinnae are 1–2 cm. long, 8–10 mm. broad, ovate to ovate-elliptical with well-rounded apex, dentate in the upper half, and lobed towards the base. They are altogether smaller than in form (*a*).

(*c.*) The pinnae are much more incised, and the pinnules approach those of typical *A. flaccidum*, being linear and acute or acuminate.

I admit, of course, that intermediates are so common in this genus that it is difficult to separate the various species, but the character here insisted

† "Journal of Botany," xxii, p. 289.

‡ *Vide* J. A. Thomson: Heredity; fig. 22, p. 99 (Mutations of Hart's Tongue Fern).

upon is that all these forms are found on one rootstock, and even sometimes on one frond. All forms are fertile, but sori are more general on the deeply incised forms.

17. **Asplenium dimorphum** Kze. (= *A. diversifolium* A. Cunn., E. 29, M. 33.)

Abundant in the bush. Commonly called on the island "the two-frond fern."

Apparently confined to Norfolk Island.

18. **Asplenium adiantioides** (L.) C. Chr. (= *A. falcatum* Lam., E. 27, M. 34.)

Common, chiefly on tree-trunks.

Lord Howe, New Caledonia, Australia, New Zealand, and widely throughout the warm regions of the Old World.

19. **Blechnum lanceolatum** (R. Br.) Sturm. var **norfolkianum** Hew., M. 25. (= *Stegania lanceolata*, E. 34.)

Common.

Kermadecs, New Zealand, Australia, Polynesia.

Blechnum discolor (Forst.) Keys., M. 24, is recorded by Maiden, but, as he now thinks, erroneously. I did not see it.

Blechnum acuminatum Baker, M. 26. This is probably identical with or only a variety of *B. lanceolatum*. *B. acuminatum* Baker is, according to Christiansen, a synonym for *B. acrodontum* (Fee) C. Chr., a Mexican plant, but Cheeseman† regards (and no doubt correctly) *Lomaria acuminata* Baker (= *B. acuminata* Baker) as a synonym of *L. norfolkiana* Hew., which in turn is a synonym of No. 18 above. Maiden considers *B. acuminatum* as intermediate between *B. attenuata* and *B. lanceolata*.

20. **Doodia caudata** R. Br., E. 32, M. 29.

Abundantly by sides of creeks, in the bush.

Australia, New Zealand, New Caledonia.

21. **Doodia media** R. Br. var. **Kunthiana** Sand., E. 33, M. 28.

Australia, New Zealand, Polynesia.

22. **Doodia aspera** R. Br., M. 28.

Perhaps only a variety of the above.

Lord Howe, Australia.

Pellaea rotundifolia Hook., M. 17, is recorded in Benth. from Norfolk Island, under the genus *Pteris*, but almost certainly in error. I did not see it.

23. **Notholaena distans** R. Br. (= *Nothoclaena distans* R. Br., M. 16.)

Near "the English Oak," hillsides near the Cascades, and other dry places.

Lord Howe, Australia, New Zealand, New Caledonia, Polynesia.

24. * **Cheilanthes tenuifolia** (Forst.) Swartz var. **Sieberi**, M. 15, E. 45 and 46.

This has also been recorded from Norfolk Island, but after search I was unable to find it. I think most probably *Notholaena distans* has been

† Manual of N.Z. Flora, p. 976.

mistaken for it. I examined dozens of plants of the latter species, but did not meet with a single specimen of *Cheilanthes*. Still, in deference to the opinions of others, I allow it to remain on the list.

Lord Howe (not recently collected), New Caledonia, Australia, New Zealand.

25. **Hypolepis tenuifolia** (Forst. f.) Bernh., M. 45.

Kermadecs, Lord Howe, New Caledonia, Australia, New Zealand, Polynesia, Malaya, China.

26. **Adiantum affine** Willd., E. 44, M. 12.

On damp grassy banks; not common.†

Kermadecs, New Zealand.

27. **Adiantum diaphanum** Blume, M. 14.

On grassy banks, and in the opener bush; common.

Kermadecs, New Caledonia, Australia, New Zealand, Polynesia, Malaya, south-east China.

Cheesem. (p. 964) gives *A. fulvum* as a native of Norfolk Island. I did not see it, and do not know what is the evidence for its occurrence there.

28. **Adiantum hispidulum** Sw., M. 13. (= *A. pubescens* Schk., E. 43.)

Perhaps the most abundant species of the genus on the island.

Lord Howe, Kermadecs, New Caledonia, Australia, New Zealand, and widely in the Southern Hemisphere.

29. **Pteris tremula** R. Br., M. 18, E. 37. (= *P. Kingiana* Endl., E. 40; *P. Baueriana* Endl., E. 40, according to Maiden.)

Mount Pitt.

Kermadecs, Lord Howe, Australia, New Zealand, Fiji.

30. **Pteris comans** Forst., E. 39 and 41, M. 23.

Anson's Bay: in forest.

Kermadecs, Lord Howe, Australia, New Zealand, Polynesia.

Forms from New Zealand, Lord Howe, the Kermadecs, and Norfolk Island differ considerably in appearance, but can scarcely be separated by any good characters.

31. **Pteris biaurita** L. var. **quadriaurita** Retz., M. 20. (= (?) *P. Trattinickiana* Endl., E. 42.)

Kermadecs, tropical and subtropical regions.

32. **Histiopteris incisa** (Thbg.) J. Sm. (= *Pteris brunoniana*‡ Endl., E. 38; *P. incisa* Thbg., M. 21.)

A large form; is common on Mount Pitt. "Oak-fern" of the islanders.

Kermadecs, Lord Howe, New Caledonia, Australia, New Zealand, and widely in tropical and subtropical regions.

† This is marked in my list as seen by me, but amongst scores of specimens of *Adiantum* in my herbarium there is not one of this species, and I am now somewhat doubtful of its existence on the island.

‡ I have received additional specimens of *Pteris* from Norfolk Island, and am now (March, 1915) convinced that *P. brunoniana* Endl. is a good species. I shall probably return to this in a subsequent paper.

33. **Pteridium esculentum** (Forst. f.) Cockayne. (= *Pteris esculenta* Forst., E. 36, M. 19.)

Common.

Kermadecs, Lord Howe, Australia, New Zealand, and southern Pacific.

34. **Vittaria elongata** Sw., M. 4. (= *V. rigida* Kaulf., E. 35.)

Common on tree-ferns.

Australia, Polynesia, eastern Asia.

35. **Cyclophorus confluens** (R. Br.) C. Chr., M. 7. (= *Niphobolus serpens* Endl., E. 21; *Polypodium serpens* Forst., M. 6.)

Abundant on tree-trunks.

Lord Howe, Australia, New Caledonia.

I do not think that *C. serpens* (Forst.) C. Chr. exists on the island. In dry seasons in exposed position the fronds of *C. confluens* become narrower and rounder, and simulate non-fertile fronds of *C. serpens*. Both kinds of frond may be found on the one rhizome. I am quite satisfied there is only one species of the genus on the island. In this opinion the late Dr. Metcalf quite concurred.

In *C. confluens* the veins anastomose; the under-surface of the frond is covered with a beautiful stellate pubescence. The non-fertile fronds are from 2 in. to 8 in. long, linear to linear-lanceolate, and often acuminate. Sori often confluent.

36. **Polypodium diversifolium** Willd. (= *P. Billardieri* R. Br., E. 19; *P. pustulatum* Forst., M. 9.)

Abundant in many situations.

Lord Howe, Kermadecs, Australia, New Zealand, New Caledonia.

P. pustulatum Forst. does not occur on Norfolk Island, but *P. diversifolium* is everywhere abundant on rocks and trees, growing rather more luxuriantly than in New Zealand. *Polypodium phymatodes* Linn., M. 10, does not, I think, occur on the island.

MARATTIACEAE.

37. **Marattia fraxinea** Smith, M. 51. (= *M. elegans* Endl., E. 17.)

Not uncommon in the beds of creeks.

New Caledonia, Australia, New Zealand, and widely, if the species is interpreted in a broad sense.

OPHIOGLOSSACEAE.

38. **Ophioglossum vulgatum** Linn.

As this was not found by the earlier botanists, it may possibly—though not probably—have been introduced. I have retained the specific name *vulgatum*, not caring to venture upon the definition of varieties without fuller material and literature.

Practically cosmopolitan.

LYCOPODIACEAE.

39. **Tmesipteris tanensis** Bernh., M. 2. (= *T. Forsteri* Endl., E. 16.)

A common epiphyte on tree-ferns.

Kermadecs, New Zealand, Lord Howe, New Caledonia, Australia, Polynesia.

40. **Psilotum triquetrum** Swartz, M. 3.

On tree-trunks in the darker forests.

Kermadecs, New Zealand, New Caledonia, Lord Howe, Australia, tropics and subtropics.

Lycopodium densum is recorded by Maiden, on the authority of Benth. (vii, 676), but there is no first-hand evidence of its collection on Norfolk Island.

GYMNOSPERMAE.

Coniferae.

41. **Araucaria excelsa** R. Br., E. 76, M. 1.

The well-known Norfolk Island pine; still abundant from the seashore to the top of Mount Pitt.

Endemic.

ANGIOSPERMAE.

Monocotyledoneae.

TYPHACEAE.

42. **Typha angustifolia** Linn. var. **Brownii** Kron., M. 130.

Longridge and in swampy watercourses in several parts of the island. This is, I think, doubtfully indigenous.

Kermadecs, New Zealand, Australia. Almost cosmopolitan.

PANDANACEAE.

43. **Freycinetia Baueriana** Endl., E. 63, M. 129.

Common in the bush, trailing and climbing.

Endemic.

GRAMINEAE.†

It becomes still more difficult in this family to distinguish between introduced and indigenous species. M. (p. 725) quotes Governor Phillip as saying, in 1788, " that not a single blade of grass has been seen on this island," and finds it " not easy to understand this statement." It appears to me that we must accept the statement as meaning at least that there was no pasturage upon the island. During the last hundred years, however, grass-seed has been frequently sent from Sydney to Norfolk Island; and this makes it certain that many Australian grasses have been imported, and will now appear to be indigenous. Now, Bauer spent many months on the island during 1804–5, and collected very carefully, and any grasses not collected by him must be regarded as quite doubtfully indigenous. We shall certainly be much safer in excluding such species than in retaining them. In one or two cases their habitats may be such as to make their introduction improbable; but the majority are found chiefly in the pasture lands. I would therefore exclude the following: *Panicum effusum* R. Br., M. 145; *Andropogon affinis* R. Br., M. 152; *Microlaena stipoides* R. Br., M. 153; *Sporobolus indicus* R. Br., M. 155.

None of these were collected until Maiden visited the island in 1902. All of them are grasses likely to be imported. Some of them may have been only temporary inhabitants of the island. I did not collect 145, 152, 153, 154, 158, of Maiden's list.

† I have to thank Mr. D. Petrie, of Auckland, the well-known authority, for his kind assistance in the determination of the species.

A special note perhaps is required about *Cynodon dactylon* Linn., which I also exclude. It is the common pasture grass of the island, yet I did not see it on Phillip Island, only three or four miles away. It is not recorded before Maiden's list, and is probably not indigenous. Maiden includes the grass both in his list of indigenous and introduced species.

44. **Andropogon refractus** R. Br., M. 151, E. 55.
Not uncommon.
Australia, Malaya, Pacific islands.

45. * **Panicum norfolkianum** Nees, E. 52, M. 144.
Apparently an endemic species; not recently collected.

46. **Panicum crus-galli** Linn., E. 51, M. 146.
According to Cheeseman, who kindly identified this for me, an unusually long-awned form.
Widely distributed in the tropics.

47. **Panicum sanguinale** Linn. var. **ciliatum** Retz., M. 147.
Norfolk Island, Phillip Island.
I retain this, as I found it on the cliffs of Phillip Island, where it is quite unlikely to have been introduced.
Kermadecs, Lord Howe, New Zealand, Australia, and warmer regions.

48. **Paspalum scrobiculatum** Linn.
Norfolk Island, Phillip Island (R. M. L.).
Kermadecs, New Zealand, Australia, Tonga, and warmer countries.

49. **Oplismenus compositus** Beauv., E. 54, M. 149.
Abundant in the forests.
A common tropical and subtropical plant.

50. **Oplismenus undulatifolius** (Kunth.) Beauv., M. 150. (= *O. aemulus* R. Br., E. 53.)
Scarcely distinct from the previous, and common on the forest floor.
Kermadecs, Lord Howe, New Zealand, Australia, Polynesia, and widely.

51. **Cenchrus calyculatus** Cav.
Edge of coastal cliffs, near Anson's Bay.
Kermadecs, Australia, New Caledonia, and warmer regions.
A new record for the island; from its situation scarcely likely to have been introduced.

52. * **Echinopogon ovatus** Beauv., M. 154.
This may have been introduced, but is a probable indigene. Recorded by Maiden only.
Lord Howe, Australia, New Zealand.

53. **Deyeuxia filiformis** (Forster) Petrie. (= *D. Forsteri* Kunth., M. 156.)
Damp ground.
Though not recorded previous to Maiden's list, I retain this. As one of the Norfolk Island forms is very slender, and perhaps distinct enough to be regarded as a variety, it is therefore scarcely likely to have been introduced. The typical form also occurs.
Kermadecs, Lord Howe, New Zealand, Australia.

54. * **Dichelachne sciurea** (R. Br.) Hook. f., M. 157. (= *D. montana* Endl., E. 56.)

Kermadecs, New Zealand, Australia.

55. * **Dichelachne crinita** (Forst. f.) Hook., M. 157.

This has been found also in the Kermadecs and Lord Howe, and therefore is perhaps indigenous to Norfolk Island.

New Zealand, Australia.

56. **Agropyron Kingianum** (Endl.) Petrie comb. nov. (= *Triticum Kingianum*, E. 58, M. 161.)

As Mr. Petrie pointed out to me, this is a true *Agropyron*. I collected it on the cliffs of Phillip Island. This is perhaps the first time it has been collected since Bauer's visit in 1804–5. The grass seems to be completely restricted to Phillip Island.

57. * **Agropyron scabrum** (R. Br.) Beauv., M. 160, E. 57.

Lord Howe, New Zealand, Australia.

CYPERACEAE.

58. **Kyllinga monocephala** Rottb., M. 135.

Abundant in watercourses and wetter pastures.

A common water-weed of warmer countries, and perhaps introduced.

Lord Howe, New Caledonia, &c.

59. **Mariscus haematodes** (Endl.) Laing comb. nov. (= *Cyperus haematodes* Endl., E. 59, M. 132.)

"Moo-oo grass" of the islanders. Formerly abundant on the banks of streams, &c. Now getting scarce, as it is largely used for basket- and hat-making. Also on Phillip Island (Bauer, R. M. L.).

Lord Howe, Australia.

I have transferred this to the genus *Mariscus*, as the glumes are persistent, the rhachilla coming away finally above the two lowest.

60. **Cyperus congestus** Vahl., M. 134.

Common in watercourses.

In the specimens examined by me there were only two stamens, instead of three as in description.

Australia, South Africa.

C. rotundus, according to Maiden, also occurs on the island, but it is probably an introduction.

61. **Eleocharis acuta** R. Br., M. 136.

Common in swampy ground.

Kermadecs, New Zealand, Australia.

62. **Scirpus nodosus** (R. Br.) Rottb., M. 137. (= *Ficinia guttata*, E. 61.)

Common, particularly on the coastal cliffs, Phillip Island (R. M. L.).

Kermadecs, Lord Howe, New Zealand, Australia, and widely in south temperate zone.

63. **Scirpus lacustris** Linn., M. 139.

Creek Mission paddock and elsewhere.

New Zealand, Australia, and in most warm and temperate countries.

64. **Scirpus maritimus** Linn. var. **fluviatilis** (Benth.) Torr., M. 141.

From an open culvert near Government House (R. M. L.); mill-dam and other places (Maiden).

New Zealand, Australia, and widely in the tropics.

65. **Scirpus cernuus** Vahl. (= *S. riparus* Spreng., M. 140.)

Watercourses, Emily Bay, and elsewhere.

Nearly cosmopolitan.

66. **Scirpus inundatus** Poir., M. 138.

In watercourses near the township.

New Zealand, Australia.

67. **Scirpus conspersus** (Nees) Laing comb. nov. (= *Isolepis conspersa* Nees, E. 60.)

Maiden, following Benth. (vii, p. 329), has identified *Isolepsis conspersa* Nees, E. 60, with the previous species. *T. conspersa* is described in Endlicher as having 3 stamens, 3–5 spikelets in a head, with the glumes purple-dotted, and the nut obscurely reticulated ("subtiliter punctata"). Now, *Scirpus inundatus* Poir. has 1 stamen, 2–15 spikelets, glumes more or less stained with dark red brown, and the nut pale and smooth. The two are obviously distinct species, and I believe that I have specimens of both from Norfolk Island corresponding exactly to the descriptions, except that in *Isolepis conspersa* the spikelets are almost terminal and generally solitary, there being no bract, or only a short one just overtopping the spikelet. I therefore propose to reinstate this species. It is perhaps endemic to Norfolk Island. Probably examples of both species were collected by Bauer, but not differentiated. *S. conspersus* is really much more closely allied to *S. cernuus* Vahl., of which the late Mr. C. B. Clarke considered it a form.

Watercourses, Norfolk Island; perhaps endemic.

68. **Carex Neesiana** Endl., E. 62, M. 142.

Not uncommon.

Endemic.

69. **Carex inversa** R. Br., M. 143.

Mount Pitt; perhaps introduced.

New Zealand, Australia.

PALMAE.

70. **Rhopalostylis Baueri** (Hook. f.) Wendl. & Drude, M. 128. (= *Areca sapida*, E. 64.)

Still abundant, though often felled for various purposes.

Endemic. Dr. Beccari has recently made the Kermadec Island plant into a new species—*R. Cheesemanii*.

AROIDEAE AND MUSACEAE.

There are many varieties of taro on the island, known by local names. Most of these have certainly been introduced—*e.g.*, Forty's taro, Sunday Island taro, &c. Maiden, however, regards *Colocasia antiquorum* Schott. as indigenous. He quotes a passage written by Governor King in 1788.

Here King says, "On the 27th I discovered a great quantity of plantane trees." The plants referred to by King as plantane-trees are regarded by Maiden as taro. The evidence adduced seems to me quite insufficient to establish the case. Though the taro may now be growing at the spot referred to, yet it also grows so commonly by the sides of streams all over the island that its presence on the stream referred to is certainly insufficient to identify it with the plantane-tree of King's records. Bauer evidently did not regard the taro as indigenous, as it is not included in Endlicher's list; and it would certainly be strange if it were to be regarded as indigenous in Norfolk Island but not in the surrounding lands and islands—*e.g.*, New Zealand, Kermadecs. As the plant is also referred to by King as the banana, there is still less reason for supposing that the plantane can be the taro. On the other hand, Endlicher regards *Musa* as indigenous, but not *Colocasia*. Now, *Musa*, though plentiful on the island, is always under cultivation, and, so far as I know, shows no tendency to escape therefrom. If King did actually find bananas growing on the island in 1788, it is probable that their presence was due to some chance human introduction by Polynesians or others in the years shortly before his arrival. This, indeed, is the more likely, as King is said to have been of the opinion that the island contained aboriginal inhabitants "from discovering the banana-tree in regular rows."

COMMELINACEAE.

71. **Commelina cyanea R. Br., M. 127.**

Apparently not found either by Endlicher or Maiden, though recorded by Cunningham. It is not uncommon in watercourses. I certainly would regard it as introduced were it not that it occurs on Phillip Island, which has never been inhabited. It has been seen there both by Cunningham and myself. In any case, I can only regard it as very doubtfully indigenous. It might quite readily have been taken to Phillip Island by the Norfolkers, or the convicts, who frequented it for birds' eggs, or the small seeds may have been carried by natural means from the mainland of Norfolk Island. Still, that it should occur and be able to maintain itself on the arid Phillip Island is undoubtedly in favour of its being indigenous.

Lord Howe, New Caledonia, Australia, with closely allied forms in south-eastern Asia.

LILIACEAE.

72. **Rhipogonum dubium Endl., E. 69, M. 121.**

Australia.

Called "yam-creeper" on the island. Common in the bush.

73. **Ceitonoplesium cymosum A. Cunn., E. 68, M. 122.**

Common in damp bush; also cultivated in bush houses on the island. Lord Howe, Australia, South Pacific to Borneo.

74. **Cordyline Baueri Hook. f.** (= *C. obtecta* Baker, M. 123; *Cordyline australis*, E. 67.)

Common in the bush. Endemic, but closely allied to the New Zealand and Australian *C. australis*.

75. **Cordyline terminalis Kunth.**

The evidence regarding this species is highly conflicting. Maiden and myself only saw it in cultivation at Steel's Point, and the Norfolkers

distinctly say that the specimens there were brought from Pitcairn with them. On the other hand, Cunningham states that it was not scarce on the island in 1830—that is, long before the arrival of the Pitcairners. Maiden suggests "that it would appear to have been exterminated, perhaps because the convicts turned it into a curse, as the Pitcairners did." It seems to me unlikely—(1) that, if common, Bauer would have missed it during his eight months on the island; (2) that the convicts could have exterminated it completely; and (3) it is probable that had they done so there would have been some record of their excesses and of the result. It is perhaps simpler to imagine that in some way Allan Cunningham was mistaken, and I would suggest that it should be removed from the list of indigenous species, unless it is found hereafter outside of cultivation on the island. It is, of course, a very likely plant to be a native of the island. It is usually regarded as an introduction in New Zealand, where the conflict of evidence is similar.

76. **Phormium tenax** Forst., E. 65, M. 125.

An undoubted native, growing on dry bare hillsides, and in such situations as *P. Cookianum* is usually found in on the New Zealand hills. I could detect no difference between this species and some of the common New Zealand forms. It was nowhere, however, luxuriant, though Captain Cook speaks of it as being more luxuriant than in New Zealand. I did not see it in any swampy places or by the side of watercourses.

New Zealand, Chatham Islands. (In the Auckland Islands it is probably introduced.)

77. **Dianella intermedia** Endl., E. 66, M. 126.

Apparently not found since the time of Bauer until my visit. The plant is undoubtedly rare. Anson's Bay (Bauer), cliffs at Ball's Bay (R. M. L.).

Rather taller and stronger than the New Zealand plant, but otherwise apparently not different. I also saw cultivated specimens brought from the Bay of Islands, New Zealand.

New Zealand, Polynesia, but the genus is chiefly Australian.

AMARYLLIDACEAE.

Crinum norfolkianum A. Cunn.

This plant grows only in wet ground in the "Old Mill" garden and in a ditch at Government House, and shows no tendency to spread. It has lived on in the same position for the last eighty years, and is still there (1913). It was evidently introduced in convict times. Cunningham differentiated it from the Australian *C. pedunculatum* Hew. I do not know the Australian species sufficiently well to say whether the differentiation is sound, but the differences are small, and may be due to cultivation. It is perhaps a form of the variable *C. pedunculatum*, of which Bentham says,† "The wild specimens in herbaria are, however, so unsatisfactory, and the cultivated ones in gardens so frequently uncertain as to their origin, that the distinction of species can only be established by studying them in their native country."

C. pedunculatum is also reported from Lord Howe and New Caledonia; but Mr. W. R. B. Oliver informs me that in the former island it is only to be found near the settlement, and may be introduced.

† Fl. Austr. vii, p. 455.

Orchidaceae.

I had little opportunity of examining the plants of this family.

78. * **Oberonia Titania** Lindl., M. 113. (= *O. palmicola* F. v. M., M. 114; *Titania miniata*, E. 71.)

Anson's Bay (Maiden).
Australia, Java.

79. **Dendrobium macropus** Benth. & Hook., M. 116. (= *Thelychiton macropus*, E. 74.)

Steel's Point and elsewhere.
Endemic.

80. * **Dendrobium brachypus** Reichb., M. 115. (= *Thelychiton brachypus* Endl., E. 32.)

Endemic.

81. * **Bulbophyllum argyropus** Reichb., M. 117. (= *Thelychiton argyropus* E. 72.)

Endemic.

82. **Phreatia limenophylax** (Endl.) Kränzl., M. 118. (= *Plexaure limenophylax*, E. 70.)

Non Benth., Fl. Austral., vi, 290; neque Bailey, Queensl. Flora, 1542.†
Epiphytic; not uncommon.
Endemic.

83. * **Microtis unifolia** (Forst. f.) R. Br. (= *M. porrifolia* R. Br., M. 119.)

Bullock's Hut (Maiden).
Kermadecs, Lord Howe, New Zealand, Australia.

Dicotyledoneae.

Piperaceae.

84. **Macropiper excelsum** (Forst. f.) Miq. var. **psittacorum** (Endl.) Laing comb. nov. (= *Piper psittacorum* Endl., E. 80; *P. excelsum* Forst., M. 93; *Macropiper excelsum* var. *major* Cheeseman.)

In the denser bush.
Kermadecs, Lord Howe, New Zealand, and South Polynesia.

Endlicher gave this plant specific rank; Cheeseman reduced it to a variety of *M. excelsum*. Endlicher's specific name should be retained for the varietal form. Maiden suggests that the typical form occurs on the island. I did not see it, and do not think it can occur.

85. **Peperomia reflexa** A. Dietr. var. **aemula** (Endl.) C. D.C., M. 94. (= *Piper aemulum* Endl., E. 77.)

Common in darker bush, on rocks and trees.
Lord Howe, Australia, New Zealand, and in most warm countries.

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† See "Das Pflanzenreich," iv, 50, ii, B. 23, p. 21, for a description of this species, and comments on the erroneous identification of it with an Australian form of Bentham and Bailey.

86. * **Peperomia Urvilliana** A. Rich., 1832, M. 95. (= *Piper simplex* Endl., 1833, E. 79; *Piper Endlicheri* Miq., 1843.)

Kermadecs, Lord Howe, New Zealand, Polynesia.

Cheeseman has retained in his Flora the specific name *Endlicheri.* The dates given show that *Urvilliana* has priority. I doubt whether this is the same as the New Zealand plant, or distinct from the following.

87. * **Peperomia Baueriana** Miq., M. 96. (= *Piper adscendens* Endl., E. 78.)

Endemic.

This plant does not seem to have been collected since the time of Cunningham, unless one or two infertile fragments that I have belong to this species. They, however, have the leaves alternate, not opposite.

The Australian *Peperomia leptostachya* Hook. & Arn. is recorded by Tate from the island, but without collector's name.

URTICACEAE.

88. **Celtis paniculata** Planch., M. 108. (= *Solenostigma paniculatum* Endl., E. 85.)

Norfolk Island and Phillip Island. The fruit is used on the island in place of holly at Christmas.

Australia, Malay Archipelago.

This tree shows on Norfolk Island a fairly distinct juvenile form. In a plant 10 ft. high the branchlets were arranged regularly and distichously along the main branch. Each was 15–20 cm. long, borne in the axis of a permanent leaf, and had 7 or 8 alternate distichous leaves. These leaves were darker in colour, and rather larger and thicker, than in the mature form.

On a full-grown tree (25 ft. high) the branchlets were no longer distichously arranged, though the leaves remained so. The lamina in the mature form are 7–9 cm. long, and in the young form 9–11 cm. long; in width, young form 4–5 cm., mature 2½–4 cm. The branchlets are deciduous, falling away from the stem.

In *Ungeria floribunda* the leaves of the young plant are also considerably larger than those of the mature form. I did not, however, see on the island any of those markedly distinct juvenile forms so common in New Zealand forests (*vide* also under *Pennantia Endlicheri*).

89. **Pseudomorus Brunoniana** Bureau var. **pendulina** (Endl.) Maiden, M. 109. (= *Morus pendulina* Endl., E. 84.)

Common in the forest.

Australia, New Caledonia.

90. **Procris montana** (Endl.) Steud., M. 110. (= *Elatostemma montanum* Endl., E. 83.)

Scarce; Now-now Valley and back of Mount Pitt, in forest.

Fiji.

91. **Boehmeria australis** Endl., E. 82, M. 111.

Bush at Now-now Valley, Joneniggabunit,† Broken Bridge.

Endemic, but closely allied to a species on Lord Howe and Kermadecs.

† *I.e.*, John the nigger burnt it.

92. **Parietaria debilis** Forst. f., M. 112. (= *Urtica debilis* Endl., E. 81.)

H. C. Quintall! (Specimen sent to Mr. W. R. B. Oliver.)

Kermadecs, Lord Howe, New Zealand, Australia, and widely elsewhere.

Malaisia tortuosa Blanco, M. 107, is excluded on the same grounds as for *Peperomia leptostachya*. It has probably been introduced in confusion with the Lord Howe plant.

LORANTHACEAE.

93. **Korthalsella articulatum** (Burn. f.) Van Tiegh. (= *Viscum distichum* Endl., E. 118; *V. articulatum* Burn. f., M. 99.)

Abundant not only on *Baloghia* and other natives, but on many introduced fruit-trees. It kills lemons, oranges, and peaches, and is quite a pest on the island.

Lord Howe, Australia, India, Polynesia.

SANTALACEAE.

94. **Exocarpus phyllanthoides** Endl., E. 91, M. 100.

Common in the forest.

One of the most durable woods on the island, but the larger trees have now all been cut down.

Endemic.

OLACACEAE.

95. **Pennantia Endlicheri** Reiss. (= *P. corymbosa* Forst., E. 140, M. 25.)

Top of Mount Pitt; not common.

Endemic.

There has long been known from Norfolk Island a species of *Pennantia* which has usually been considered to be identical with the New Zealand *Pennantia corymbosa*. It appears first of all in Endlicher, p. 80, No. 140 (1833), and there Endlicher identifies it with Forster's *P. corymbosa* from New Zealand. In 1842 Reissek made a separate species of it, under the name *P. Endlicheri*,† and is followed by the "Index Kewensis." Maiden, however, regards it as synonymous with *P. corymbosa*, and states (M. 25), "I am of opinion that the Norfolk Island species is identical with the New Zealand one." This opinion seems to me scarcely justifiable, and for reasons about to be given I think that the specific name "*Endlicheri*" must be revived for the Norfolk Island plant, and the species must be regarded as distinct.

On examining the Norfolk Island form it is apparent at a glance that the leaves are larger and more membranous than in the New Zealand species. Indeed, similar differences exist between the two as between *P. excelsum* and *P. excelsum* var. *psittacorum* of the Kermadecs and Norfolk Island. Such differences as these are perhaps scarcely sufficient to give specific rank to *P. Endlicheri*. Further small differences also exist in the foliage. In the Norfolk Island plant the branchlets and petioles are glabrous, or provided only with a few sparse hairs on twigs and midrib. In the New Zealand plants these parts are pubescent. In Norfolk Island specimens the lower leaves are larger than those surrounding the tips of the branches or the inflorescence, having the blade 18–25 cm. long and 10–15 cm. broad.

† "Linnaea," xvi, p. 341, t. 13.

The margins are entire, repand, or irregularly notched, with shallow indentations; the upper surface is highly polished (in the New Zealand plant it is dull); the under-surface is not polished, and of a lighter green in colour. The upper leaves are about 10–15 cm. long and 6–8 cm. broad. The leaves are thus very much larger than those of the New Zealand species, which in the South Island, at any rate, do not average more than about half of these dimensions. The flowers on both varieties seem to be very similar. Endlicher (*loc. cit.*) states that the Norfolk Island plant is hermaphrodite, with very rare male flowers among the others, but this is not so, for though the female flowers do contain stamens, these are non-fertile. On other specimens male flowers may be found without any trace of an ovary. The plant is really dioecious, as in New Zealand; indeed, the flowers of both species agree well in all respects.

A difference, however, of a still more important type than those already mentioned has yet to be recorded. As is well known, the New Zealand plant goes through a juvenile stage which is very different from the mature form. There is no trace of any such juvenile stage in the Norfolk Island plant. This is an important and most interesting fact, and should be compared with the similar facts known regarding the Chatham Island *Plagianthus betulinus* and *Pseudopanax chathamicum*.† In the case of *Plagianthus betulinus*, Cheeseman (p. 77) does not consider the absence of the juvenile form a sufficient difference for the demarcation of a species; but it seems to me that it should be considered of at least varietal importance, and here I have regarded it, together with the other points mentioned, as justification for differentiating a species.

POLYGONACEAE.

96. **Muehlenbeckia australis** (A. Rich.) Meissn., M. 92. (= *Polygonum australe* A. Rich., E. 86.)

Common in the forest, and apparently identical with the New Zealand form. Phillip Island (A. Cunn.).
New Zealand.

Rumex Brownii Campd., M. 91, also occurs on the island, but obviously as an introduced weed.

AMARANTACEAE.

97. **Achyranthes arborescens** R. Br., M. 89, E. 89.

Mount Pitt.
Endemic.

98. **Achyranthes aspera** L., M. 90. (= *A. canescens* R. Br., E. 90.)

Cliffs, chiefly costal.
Lord Howe, New Caledonia, Australia, and generally in warm countries.
The plant varies a good deal in the colour and hispidity of the leaf and stem.

Alternanthera sessilis R. Br. also occurs on the island (W. Laing!), but is probably an introduced weed.

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† *Vide* Cockayne, "An Inquiry into the Seedling Forms of New Zealand Phanerogams," T.N.Z.I., vol. 23, p. 277; and vol. 32, p. 89.

NYCTAGINACEAE.

99. **Pisonia Brunoniana** Endl., E. 88, M. 88.

On the western side of the island; common.

Kermadecs, Lord Howe, New Zealand, Australia, and south-eastern Pacific.

AIZOACEAE.

100. **Mesembryanthemum aequilaterale** Haw., M. 41.

Lord Howe, New Zealand, Australia, and widely in America.

Like Maiden, I did not find *M. australe* Sol., E. 129, and think it probable that it has been recorded in place of *M. aequilaterale* Haw., which is also on Phillip Island (R. M. L.).

101. **Tetragonia expansa** Murr. var. **cornuta** (Gärtn.) Endl., E. 130A.

This is the New Zealand form, and is common on the coastal cliffs.

Kermadecs, Lord Howe, Australia, New Zealand, and perhaps elsewhere.

102. **Tetragonia trigyna** Banks & Sol. (= *Tetragonia expansa*, Murr. var. *stronglyocarpa* Endl., M. 42, E. 130B.)

Common on the sea-banks.

Kermadecs, New Zealand, and probably also Australia and Lord Howe.

RANUNCULACEAE.

103. ***Clematis glycinoides** D.C., M. 1.

This appears in the Sydney Herbarium as collected by Mr. I. Robinson, of Norfolk Island.

Lord Howe, Australia, New Caledonia (?), Polynesia.

104. **Clematis cocculifolia** A. Cunn.

Mrs. W. Laing; Mount Pitt!

I give the original description, as it is not easily accessible, and the species has only hitherto been recorded by A. Cunningham: "*C. cocculifolia*, floribus paniculatis dioicis, 4-sepalis, foliis indivisis longe petiolatis orbiculato-ovalibus obtusis membranaceis, 5-nerviis integerrimis glabris, basi saepe cordatis, sepalis oblongis margine lanatis, antheris ovatis obtuse apiculatis. Crescit in locis apricis, praesertim in marginis sylvarum caeduarum insulae Norfolk, ubi Augusto Septembrique floret."

The plant is obviously now very rare, and apparently endemic. Maiden, following Cunningham, is in error in regarding it as a native of New Zealand. It is very close to the preceding species.

Ranunculus parviflorus Linn., M. 2, recorded by Maiden, is probably an introduction, as in New Zealand, and only adventive. I did not get it. *Ranunculus repens* has also been introduced.

CRUCIFERAE.

Nasturtium palustre D.C. (Syst., ii, 91). (= *N. sylvestre* A. Rich., M. 3.)

This is reported from Norfolk Island on the authority of Cunningham: "Wet ravines and running streams." Not found by me, and apparently not by Maiden. It has probably been introduced temporarily, and then has disappeared. *N. officinale* is abundantly naturalized. *Senebiera didyma* is also abundant.

Cakile maritima Scop. Reported only by Maiden.

Almost certainly introduced and adventive. New Zealand examples show how easily even a maritime plant may be introduced, and appear in unexpected situations. Probably most of the supposed "Scandinavian element" in southern floras is due to such introductions.

CAPPARIDACEAE.

105. **Capparis nobilis** (Endl.) F. v. M., M. 5. (= *Busbeckia nobilis*, Endl., E. 121.)

A common bush liane, scrambling to the tops of the trees. Known on the island, on account of its recurved spines, as "Devil's guts."

Apparently endemic, but very close to the Australian *C. arborea* F. v. M. (Frag., i., 163).

It may possibly be the same as the Queensland *C. ornans* F. v. M., but I have no material with which to decide the question. The following points should be noted with regard to the Norfolk Island plant: It belongs to the section of the genus that has the two outer sepals united in the bud; the non-flowering branches are provided with two reflexed stipulary spines about 6 mm. long. According to Maiden, the fruit is almost globular, but this is scarcely so. It is globular only in the early stages, and when mature the fruit is usually of the size, shape, and colour of the common edible passion-fruit (*Passiflora edulis*). Occasionally only is it nearly globular.

PITTOSPORACEAE.

106. **Pittosporum bracteolatum** Endl., E. 138, M. 9.

Common in the bush.

Endemic.

I have also a fragment of an undetermined *Pittosporum* collected on the island by Mr. H. C. Quintall, and forwarded me by Mr. W. R. B. Oliver. It may well be introduced.

LEGUMINOSAE.

107. **Canavalia obtusifolia** P. D.C., M. 30. (= *C. Baueriana* Endl., E. 150.)

Coastal banks; common.

Kermadecs, Lord Howe, Australia, and tropics.

108. **Milletia australis** (Endl.) Benth., M. 28. (= *Pterocarpus australis* Endl., E. 152.)

Now confined to a strip of country running across the middle of the island. As it rarely fruits, it is doubtless doomed to extermination. I saw only one legume.

Phillip Island (A. Cunn.), Australia.

109. * **Vigna retusa** Walp., M. 31. (= *Callicysthus volubilis* Endl., E. 149.)

Lord Howe, New Caledonia, Australia, and widely in the tropics.

110. **Caesalpinia Bonducella** Fleming, M. 32.

A few specimens only exist in an open paddock near the centre of the island. Apparently found only by Cunningham and myself. It is quite

possibly introduced. It is known on the island as "tatary maw," an obvious corruption of the Maori "tataramoa" (*Rubus australis*), in allusion to its thorny nature. Probably will soon be exterminated.†

Lord Howe, Australia, and widely in the tropics.

111. * **Glycine tabacina** Benth., M. 29.

Recorded only by Maiden, and perhaps introduced.

Australia, New Caledonia, and South Sea Islands.

112. * **Streblorrhiza speciosa** Endl., M. 33, E. 151.

Now only known from a solitary drawing. The plant once grew on Phillip Island, and is almost certainly extinct.

Endemic.

Geraniaceae.

Maiden records *Pelargonium australe* and *Geranium dissectum*, M. 20 bis, but I think they have been introduced. They are found chiefly in gardens and waste places, though I obtained *G. dissectum* on the top of Mount Pitt; but there are numerous other naturalized weeds there. *Erodium cicutarium* also occurs.

Oxalidaceae.

113. **Oxalis corniculata** L. var. **reptans** (Soland.) Laing.

Captain Cook mentions in his discovery of the island that he found "cabbage-palm, wood-sorrel, sow-thistles, and samphire abounding in some places on the shore." In Endlicher's list there appears under No. 128, *Oxalis reptans* Soland. ex Forst. Prodr., but the name is a *nomen nudum*, though Endlicher remarks, "Mera fortassis Oxalidis corniculatae varietas." Bauer apparently did not collect an *Oxalis* in Norfolk Island. No *Oxalis* appears in Maiden's list of indigenous species, though *O. corniculata* appears in his list of introductions. I, however, found a little *Oxalis* common on rocky places near the seashore on Phillip Island as well as on Norfolk Island. It is apparently a form of *P. corniculata*. It can scarcely be other than the *O. reptans* of Forst. Prodr. I give a short diagnosis.

Oxalis corniculata L. var. *reptans* (Soland.) Laing. Planta pilosa caule decumbenti vel reptanti, crasso fruticosoque, fructibus linearo-oblongis, acuminatis.

The whole plant is stouter, and rather larger in all its parts than the common New Zealand forms. It is usually densely pilose, except in the lower portions of the stems, but some specimens are met with in which there are no hairs on the upper surfaces of the leaves. The stem is suffruticose at the base. The capsules are about 12 mm. long, and 2–3 mm. broad at the base, narrowing at the top to an acuminate point. It is evidently a coastal plant, growing in the sand or in clefts of rocks.

‡ New Caledonia, Kermadecs, Lord Howe, and almost cosmopolitan.

One species at least of the South African Oxalids occurs as a garden escape.

† Since writing the above I have noticed that it appears in Cheeseman's "Flora of Rarotonga," with the Native name of *tataramoa*, thus confirming my conjecture.

‡ This is the distribution of the species; the variety may be endemic, though perhaps near var. *crassifolia*.

LINACEAE.

Maiden records *Linum marginale* A. D.C., but, as in New Zealand, it is almost certainly introduced. It springs up sporadically in different places, and then apparently dies out. Thus it can only be adventive. *Linum gallicum* also occurs.

RUTACEAE.

114. **Evodia littoralis** Endl., E. 146, M. 21.

Not uncommon up to the top of Mount Pitt.
Endemic.

115. **Acronychia Endlicheri** Schott., M. 22. (= *Vepris simplicifolia* Endl., E. 148.)

Common.
Australia.

116. **Zanthoxylum Blackburnia** Benth.,† M. 23. (= *Blackburnia pinnata* Forst., E. 147.)

Common, and on Phillip Island.
Lord Howe, New Caledonia, Vavau.

MELIACEAE.

117. **Dysoxylum Patersonianum** (Endl.) Benth. & Hook. f., M. 24. (= *Hartsighea Patersoniana* Endl., E. 139.)

A common tree on the island; also on Phillip Island.
Endemic.

EUPHORBIACEAE.

118. * **Euphorbia obliqua** Endl., E. 144, M. 101.

Not recently collected, and probably now extinct.
Tonga.

119. **Euphorbia glauca** Forst., E. 145, M. 102.

I believe I saw this south of Steel's Point, but am not certain.
New Zealand.

Euphorbia norfolkiana Boissier, M. 103. Possibly a New-Hebridean plant, cultivated on Norfolk Island. The evidence for its occurrence on the island in an indigenous state is by no means satisfactory. Not collected by Maiden or myself.

120. **Euphorbia Sparmanni** Boissier, M. 104.

Emily Bay.
Lord Howe, Australia, Pitcairn Island, Tonga.
(It closely resembles the more widely distributed *E. atoto*.)

121. **Baloghia lucida** Endl., E. 143, M. 105.

A common tree; also on Phillip Island.
Lord Howe, Australia, New Caledonia, Polynesia.

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† *Zanthoxylum* (1737) has priority over *Xanthoxylum* (1791) used by Maiden.

122. Excoecaria Agallocha L., E. 142, M. 106.

Near the beach in wind-shorn bush and clumps from Bamboras to Ball's Bay. According to Pax ("Das Pflanzenreich," iv, 47, p. 167), two varieties occur on Norfolk Island—var. *a. genuina*, and var. *δ. ovalis*.

New Caledonia, Australia to tropical Asia.

Phyllanthus sp. (= *P. Veillardii ?*) grows abundantly in the paddocks, and does not seem to have been recorded. It is probably an introduced species from New Caledonia.

123. Homalanthus populifolius Graham.

A few trees in a deep rocky ravine on Mount Pitt (H. C. Quintall !).† Forwarded me by Mr. W. R. B. Oliver. New for the island, though see M., p. 748.

Lord Howe, Australia.

CELASTRACEAE.

124. Elaeodendron curtipendulum Endl., E. 141, M. 26.

One of the commonest trees on the island—"maple."

Lord Howe (?).

SAPINDACEAE.

125. Dodonaea viscosa L., M. 27.

Anson's Bay, and towards the north-west, near the coast only, Duncombe's Bay, Bullock's Hut.

New Zealand, Australia, some of the South Sea Islands, and widely in warm countries.

(Close to *D. lanceolata* of Lord Howe Island.)

This plant is not recorded by Endlicher, and yet is fairly common over a limited area, and undoubtedly indigenous. I would explain the omission from Bauer's collection by saying that in his time Anson's Bay must have been inaccessible by land, and it is almost inaccessible by sea. If there were many such omissions from Bauer's list it would be impossible to regard absence from it of a species now common on the island as evidence against a plant being indigenous. *Melicytus ramiflorus* is another striking omission.

MALVACEAE.

(Maiden records *Malvastrum tricuspidatum* Grey, M. 12. *Modiola multifida* Moench. is also common in pastures and waste lands. Both are undoubtedly introduced. The former is known on the island as "Little Jack," and is very abundant. "Big Jack" is *Sida rhombifolia*.)

126. Abutilon Julianeae Endl., E. 35, M. 13.

Rocky clefts, back of Mount Pitt. Evidently very rare, and in danger of extermination. Dr. Metcalf informed me that it occurred in Ball's Bay. I did not see it there.

Endemic.

† My father (Mr. W. Laing), in sending me a specimen of *Homalanthus*, informs me that it is fairly common. (March, 1915.)

127. Hibiscus diversifolius Jacq., E. 133, M. 14.

Mission paddocks only, where it shows no sign of spreading. This might have been definitely regarded as indigenous, except for Bauer's note quoted by Endlicher, "ipso Bauero adnotante vix spontaneus." Its presence in cultivated ground only adds to the improbability of its being indigenous. Still, its distribution suggests the likelihood of its occurrence in Norfolk Island. It is most unlikely that we shall arrive at any certainty in the matter. In New Zealand it has disappeared quickly, and it may be following the same process in Norfolk Island.

Lord Howe, New Caledonia, New Zealand, Australia, Pacific islands, &c.

128. Hibiscus tiliaceus L., E. 131, M. 15.

Near the tops of the cliffs on entering Anson's Bay from the south.

Lord Howe, New Caledonia, Australia, and widely distributed through the Asiatic tropics as far as India, and also in the Pacific islands.

129. Hibiscus insularis Endl., E. 132, M. 16.

Endemic on Phillip Island.

A few plants still remain on the island, but those that I saw were in a most unhealthy condition, being covered with coccids, aphides, smuts, and other blights and pests. They were obviously maintaining an unequal struggle with an unfavourable environment.

H. pedunculatus L. of South Africa grows in the bush, and is doubtless a garden escape.

130. Lagunaria Patersonii (Ait.) Don, E. 134, M. 17.

Next to *Araucaria excelsa* the most abundant tree on the island; also on Phillip Island (R. M. L.).

On the coast it is wind-shorn, and reduced to a shrub closely appressed to the sea-banks, though elsewhere throughout the island it is a tall spreading tree.

Lord Howe, Australia.

STERCULIACEAE.

131. Ungeria floribunda Schott. & Endl., E. 137, M. 18.

Not uncommon in the denser forest, particularly on the north-west side of the island. The leaves of the young trees are much larger than those of the mature plant.

Endemic.

FRANKENIACEAE

Frankenia pauciflora D.C., M. 10.

The only place where I saw this was between the cobble-stones on the approach to the pier. It has probably been introduced from Australia.

VIOLACEAE.

132. Viola Betonicaefolia Sm., M. 8.

This seems to have been hitherto collected only by Backhouse. It is not uncommon in open pastures on the island. Quite possibly introduced.

Australia.

133. ***Hymenanthera latifolia** Endl., E. 127, M. 6.

I did not get this, and it is not clear whether it was collected by Maiden. It is not in the herbarium of the Sydney Botanic Gardens. It has recently been separated by Hemsley from the New Zealand species ("Kew Bulletin," 1908, p. 95), which now is *H. novae-zealandiae.* It is probably scarce on the island, or perhaps extinct.

Lord Howe (?).

134. **Melicytus ramiflorus** Forst., M. 7.

Not uncommon in the bush, and apparently not to be distinguished from the well-known New Zealand plant.

Kermadecs, New Zealand, Tonga, Fiji.

PASSIFLORACEAE.

135. ***Passiflora Baueriana** (Endl.) Mast., M. 36. (= *Disemma Baueriana* Endl., E. 123.)

This has not been found on the island recently, and is either very rare or extinct. It is mentioned by Backhouse, but see next species.

Endemic.

136. **Passiflora glabra** Wendl., M. 37. (= *Disemma adiantifolia* Endl., E. 122.)

Common in the forest.

It is quite possible that there has been only one species of *Passiflora* on Norfolk Island. Endlicher mentions two, but admits that only one is present in Bauer's herbarium. He states that the two species differ thus: *Disemma adiantifolia*, petioles glandular, bases of leaves truncate, rays barely equalling the corona; *D. Baueriana*, petioles glandular at the apex, base ovate, rays slightly exceeding the length of the corona. I did not examine the petioles for glands in fresh specimens, and can say nothing on this point; but I find the leaves variable, and the bases on the same plant either truncate or ovate. The rays in the specimens examined by me sometimes exceed, at other times barely equal, the corona.

Apparently the only direct authority for the occurrence of two species on the island is that of Backhouse, who was not a botanist. Maiden identifies his specimens as *Passiflora glabra* Wendl. (= *D. adiantifolia*). I find it difficult with the material and literature at my disposal to decide definitely which of the species is now represented on the island, but have followed Maiden.

Endemic.

THYMELAEACEAE.

137. **Wickstroemia australis** Endl., E. 92, M. 98.

A common shrub.

Endemic, but close to the widely distributed *W. indica* of the Pacific, Australia, and the Malay Archipelago.

Pimelea linifolia Banks & Sol., E. 92.

Is excluded by Maiden, and no doubt rightly so. I did not get it.

LYTHRACEAE.

Lythrum hyssopifolium L., M. 35.

A palaearctic plant, and almost certainly introduced. Occurs at Emily Bay and Bloody Bridge.

MYRTACEAE.

Maiden records *Rhodomyrtus psidioides*, M. 34, an Australian rose-myrtle. He regards it as only doubtfully indigenous. I did not get it, and think that it has been possibly an escape from cultivation. The complete, or almost complete, absence of the *Myrtaceae* from the island is noteworthy.

ARALIACEAE

138. **Meryta latifolia** (Endl.) Seem., M. 45. (= *Botryodendron latifolium* Endl., E. 119.)

Apparently becoming less common on the island.
Endemic.

139. **Meryta angustifolia** (Endl.) Seem., M. 46. (= *Botryodendron angustifolium* Endl., E. 120.)

Common in moister forest.
Endemic.

UMBELLIFERAE.

140. **Apium prostratum** (Thouars.) Labill., M. 43.

A common coastal plant. The form on the island is var. *a* of Cheeseman.

Kermadecs, Lord Howe, New Zealand, and widely in the Southern Hemisphere.

Apium leptophyllum F. v. M. is a common weed, generally found in gardens, and is probably naturalized -M. 44.

141. **Daucus brachiatus** Sieb.

Collected by H. C. Quintall, and forwarded me by Mr. W. R. B. Oliver. I add this tentatively to the list of natives. It seems quite possible that it may be indigenous, and that it may have been overlooked by previous collectors.

New Zealand, Chatham Islands, Australia (?), western America.

MYRSINACEAE.

142. **Rapanea crassifolia** (R. Br.) Mez., M. 63. (= *Myrsine crassifolia* Endl., E. 95.)

One of the common trees on the island.

Australia, and close to the Kermadec *Rapanea kermadecensis* Cheesem. I know nothing of *Suttonia* (?) *tenuifolia* Mez. ("Pflanzenreich," heft 9, iv, p. 335).

PLUMBAGINACEAE.

I cannot accept *Plumbago zeylanica* Linn., E. 87, M. 11, as indigenous. I only saw it in garden hedges. Dr. Metcalf and other old residents told me it was certainly imported, and never found except on land that had been occupied by gardens. It was introduced in the convict days, and may possibly have escaped from cultivation to some extent at one time, but there is no sign of it now outside certain hedges. Cunningham found it on Phillip

Island, where it had been taken, no doubt, by human agency, by intent or accident. Other garden escapes are to be found there. I was assured, for example, that certain plants I saw at the foot of the cliffs at one place on Phillip Island were tomatoes. There seemed no reason to doubt the statement, but I was unable to obtain specimens.

Sapotaceae.

143. * **Sideroxylon costatum** (Endl.) F. v. M., M. 64. (= *Achras costata* Endl., E. 96.)

Phillip Island (A. Cunn.), Norfolk Island (Maiden).
Australia.
The New Zealand plant, according to Hemsley, is distinct.

Primulaceae.

144. **Samolus repens** (Forst.) Pers. var. **strictus** Cockayne, E. 94, M. 62.

Common on coastal rocks, near high-water mark.
Kermadecs, New Caledonia, New Zealand, Australia

Oleaceae.

145. **Olea apetala** Vahl., E. 112, M. 66.

A common tree; also on Phillip Island.
New Zealand.
The species is identical in both localities.

146. **Jasminum simplicifolium** Forst., M. 65. (= *J. gracile* Endl., E. 111.)

The commonest liane on the island. It grows prostrate on the coastal cliffs, but elsewhere produces a sturdy trunk 15 cm. through, and climbs to the top of the highest trees.
New Caledonia, Lord Howe, New Hebrides, Australia, Fiji, and Tonga.

Apocynaceae.

147. **Melodinus Baueri** Endl., E. 113, M. 67.

A common forest-liane.
Endemic.

148. **Alyxia gynopogon** Roem. & Schuldt., E. 114, M. 68.

A common shrub in the darker forest.
Endemic.

Gentianaceae.

Erythraea australis R. Br., M. 70, is a common weed in the fields and pastures. It is definitely, and no doubt correctly, stated by the islanders to have been introduced with grass-seed.

Asclepiadaceae.

149. **Tylophora biglandulosa** (Endl.) A. Gray, M. 69. (= *Hybanthera biglandulosa* Endl., E. 115.)

A not uncommon liane; Mount Pitt.
Endemic, but very similar to *T. enervia* of Lord Howe Island.

CONVOLVULACEAE.

150. **Ipomoea bona-nox** L., M. 72. (= *I. ambigua* Endl., E. 108; *I. carinata*, E. 107.)

A beautifully scented nocturnal flowering creeper, now quite rare. It will probably be soon extinct on the island if it is not cultivated.

William's Water and back of Mount Pitt.

Lord Howe, and widely spread in the tropics, but perhaps indigenous only in tropical America.

151. **Ipomoea congesta** R. Br., M. 74. (= *I. cataractae* Endl., E. 106, M. 73.)

I am quite satisfied that there are not two distinct species, *I. cataractae* and *I. congesta*, on the island. Mr. Maiden writes to me thus on the subject: "The two species seem to be very similar (we have only one, *I. congesta*, in the herbarium), but they are placed in D.C.'s Prodromus in two different sections—*i.e.*, *I. cataractae* is placed in section *Cephalanthae*, which has almost capitate clustered flowers (floribus aggregato-capitatis): *I. congesta* is placed in a section '*integrifolia*,' which has not capitate flowers (floribus non-capitatis). *I. cataractae* seems to be more hirsute, though the hairs are silky, and the leaves are mostly obscurely 3-lobed; *I. congesta* is a softly tomentose climber with entire leaves, though the leaves are cordate in both. The proportion, size of calyx and corolla, is different. Endlicher describes the corolla in *I. cataractae* as twice as long as the calyx, while the corolla in *I. congesta* is three or four times as long as the calyx. Backhouse describes *I. cataractae* as having large purple flowers shot with red; *I. congesta* has brilliant carmine flowers."

Now, there is a species of *Ipomoea* occurring in the Cascades which is undoubtedly the plant called by Endlicher *I. cataractae*. It occurs not uncommonly between the Cascades and Steel's Point, and in the section of the island lying immediately behind this portion of the coast-line. I examined many specimens of it in a fresh state on the island, and satisfied myself that in spite of certain variations it represented only one species. The leaves are softly villous, almost tomentose on both sides, though sometimes on the upper surface the hairs are sparse. They are usually entire, though perhaps occasionally obscurely 3-lobed. The corolla is two or three times as long as the calyx. The flowers vary in colour from white to carmine, and are frequently shot with red. There are usually one to three flowers attached to short pedicels, which are borne on a longer peduncle. The flowers are certainly not capitate. In all these points I see nothing to separate the plant from *I. congesta*. Further, *I. congesta* is recorded from the island without collector's name by Maiden. It only remains to find which specific name—*cataractae* or *congesta*—has priority, and this belongs to *I. congesta*, published in 1810. *I. cataractae* was not published till 1833.

Australia, Polynesia.

152. **Ipomoea pes-caprae** Roth., M. 75.

Recorded only by Maiden. I got a young plant with leaves characteristic of this species, but it was too immature for certain identification.

New Caledonia, Kermadecs, Lord Howe, Australia, tropics.

153. **Ipomoea palmata** Forst., M. 76. (= *I. pendula* R. Br., E. 105.)

Most abundant everywhere, particularly on the outskirts of the bush; sometimes with white flowers.

Kermadecs, Lord Howe, New Zealand, Australia, and tropics.

154. * **Calystegia Soldanella** (L.) R. Br., E. 105 (for 104). (= *Convolvulus Soldanella* Linn., M. 78.)

Kermadecs, Lord Howe, New Zealand, Australia, and cosmopolitan.

155. **Calystegia marginata** R. Br. (= *C. affinis* Endl., E. 108; *Convolvulus affinis*, M. 77; *C. marginatus* Spreng., Benth. Fl., iv. p. 430, M. 79.)

A bush-climber; apparently rare. I saw only two specimens—one brought me from Mount Pitt by Mr. Gus Allen, and the other obtained by Mr. W. Laing. The large bracts and 1-celled ovary place it in *Calystegia* rather than in *Convolvulus*.

Lord Howe, New Zealand, Australia.

156. **Dichondra repens** Forst.

Ball's Bay, on a dry steep bank; easily overlooked, and hence not hitherto recorded. No doubt indigenous.

New Zealand, Australia, and widely in tropical and subtropical regions.

BORAGINACEAE.

Cynoglossum australe R. Br., M. 71.

Apparently found only by Cunningham "near the settlement," unless some scarcely identifiable specimens of mine belong to this species. It has probably been introduced from Australia, and is only adventive.

VERBENACEAE.

Verbena officinale L., M. 86.

Occurs in waste places as in New Zealand, and is doubtless introduced.

157. * **Vitex trifola** L.

Apparently collected only by Cunningham.

New Caledonia, Polynesia, and tropics of Old World.

158. **Myoporum obscurum** Endl., E. 110, M. 85.

Called on the island "popcorn-tree"; common; also on Phillip Island. Endemic, but closely related to the New Zealand *M. laetum*.

BIGNONIACEAE.

Tecoma australis R. Br., M. 84, is cultivated on the island, but there is not sufficient evidence to show that it is also indigenous.

SOLANACEAE.

159. * **Solanum Bauerianum** Endl., E. 109, M. 80.

Apparently this has not been collected on Norfolk Island since Bauer's time.

Lord Howe.

160. **Solanum nigrum** L., M. 81.

Abundant. A cosmopolitan weed. It may have been introduced.

Lord Howe, Kermadecs, &c.

161. * Solanum aviculare Forst., M. 52. (= *S. laciniatum* Ait.)

A. Cunningham noted this plant "near the settlement." It was quite likely a temporary garden escape, though, of course, it is also a probable indigene. It does not occur now unless in gardens. At the same time, it is a species that in New Zealand at least speedily disappears before cultivation (*e.g.*, on Banks Peninsula). It is also reported from Lord Howe Island. I have for these reasons left it on the list.

Kermadecs, Lord Howe, New Zealand, Australia.

SCROPHULARIACEAE.

Veronica calycina R. Br., M. 83, is probably introduced. I obtained it at Pop Rock. It is noteworthy that no New Zealand species of *Veronica* occur on Norfolk Island.

RUBIACEAE.

162. Coprosma Baueri Endl., M. 47. (= *C. lucida* Forst., E. 117.)

I obtained this on rocky cliffs, both on Norfolk Island and on Phillip Island, but it is very rare. It was not obtained by Maiden. It also occurs on the Moo-oo Stone, a rock off the north coast.

Endlicher describes *Coprosma lucida* as occurring on Norfolk Island in the Prodromus, but has no reference to *C. Baueri*, which he described later. Now, *C. lucida* has not since been found on the island, and in spite of a special search for it I did not get it. His description of *C. lucida*, however, agrees well not with the New Zealand *C. lucida* but with *C. Baueri*. I have little doubt that Endlicher confused *C. Baueri*, which he obtained on Norfolk Island, with *C. lucida* (Forst. Prodr. and Rich. Fl. Nov. Zeel.). He himself, indeed, points out several discrepancies between his plant and the descriptions of others—*e.g.*, the *C. lucida* of Endlicher has the leaves ovate and retuse. Now, my specimens of *C. Baueri* from Norfolk Island are markedly retuse, and the leaves are ovate to oblong. Again, Endlicher describes the "Flores feminei . . . . pedicellis basi, medio et apice bibracteolatis, bracteolarum pari supremo flores sessiles 3–6, raro plures cupulatim recipiente." This exactly fits my Norfolk Island specimens of *C. Baueri*. I have no doubt, therefore, that Endlicher first confused his Norfolk Island specimens with *C. lucida* Forst., and then afterwards re-described them as *C. Baueri*. Unfortunately, I have not access to his original description of *C. Baueri*. *C. lucida* Forst. must therefore be removed from the list of Norfolk Island species. Since writing the above, I noticed that Hemsley ("Annals of Botany," x, p. 239) and Cheeseman (p. 247) have both pointed out the identity of *C. lucida* Endl. with *C. Baueri*.

(?) Kermadecs, Lord Howe, New Zealand, Chatham Islands.

The form is somewhat different in each of these groups. The New Zealand species should probably be regarded as a distinct variety of *C. Baueri*.

163. Coprosma pilosa Endl., E. 116, M. 49.

A small fastigiate tree, not uncommon on the lower slopes of Mount Pitt. When the plant grows in the open the leaves are much smaller and harder than when it occurs in the bush.

Endemic.

CAMPANULACEAE.

164. **Wahlenbergia gracilis** A. D.C., M. 60.

Top of Mount Pitt.
Kermadecs, New Caledonia, New Zealand, Australia, &c.
Perhaps indigenous, but also a probable introduction.

165. **Lobelia anceps** Thunb., M. 61. (= *L. alata* Labill. var. *stolonifera*, E. 97.)

The maritime form only; abundant on the rocks.
Lord Howe, Kermadecs, New Zealand, Australia, and widely.

CUCURBITACEAE.

166. **Bryonopsis affinis** (Endl.) Cogn., M. 38. (= *Bryonia affinis* Endl., E. 125.)

Common on Mount Pitt and at Steel's Point.
Polynesia, and very close to the Australian *Bryonia laciniosa* Linn.

167. * **Sicyos angulatus** L., E. 124, M. 39. (= *S. australis* Endl., E. 124.)

Lord Howe, Kermadecs, New Zealand, Australia, and very widely.

168. **Melothria Baueriana** (Endl.) F. v. M., M. 40. (= *Zehneria Baueriana* Endl., E. 126.)

Mission Paddocks, Mount Pitt.
Endemic.

COMPOSITAE.

(*Taraxacum dens-leonis* Desf. was introduced by Dr. Metcalf, and *Vernonia cinerea* Less., M. 50, by Mr. T. Buffet in grass-seed from Australia. *Cotula australis* Hook. f., M. 55, and *Picris hieracioides* L., M. 59, also occur, probably as introduced weeds. The last-mentioned grows sometimes in the bush, and is possibly, though not probably, indigenous.)

169. **Gnaphalium japonicum** Thunb., M. 51. (= *G. lanatum* Forst., E. 99, and *G. involucratum* Forst., E. 100.)

Common.
Kermadecs, Lord Howe, New Zealand, Australia, and elsewhere—a widely distributed weed.

170. **Gnaphalium luteo-album** L., E. 98, M. 52.

Common.
Cosmopolitan in temperate and tropical regions.

171. **Wedelia biflora** D.C., M. 53. (= *W. Fosteriana* Endl., E. 102.)

Common on the sea-banks, forming a matted mass of trailing stems; often covering many square feet of the shore. Phillip Island (R. M. L.).
Lord Howe, Australia, New Caledonia, and widely in the tropics of the Old World.

172. **Erechtites arguta** (Rich.) D.C., M. 56. (= *Senecio argutus* Rich., E. 101.)

A common weed.
New Zealand, Australia.

173. **Senecio lautus** Forst., M. 57.

I got a form of this on the beach near the Cascades.
Kermadecs, New Zealand, Australia.

174. **Sonchus oleraceus** L., M. 58.

Sow-thistle. Was recorded by Captain Cook, but was not listed until Maiden collected it. Phillip Island also (R. M. L.).
Everywhere except in the frigid zone.

175. **Bidens pilosa** L., M. 54.

Quite probably only naturalized, as it was not collected by Bauer or Cunningham.
Lord Howe, New Caledonia, Kermadecs, New Zealand, Australia, and widely in warm and temperate regions.

ART. II.—*Notes on Aciphylla, with Descriptions of New Species.*

By T. F. CHEESEMAN, F.L.S., F.Z.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 16th December, 1914.*]

IT is somewhat singular that the genus *Aciphylla*, so readily identified from its remarkably distinct and conspicuous habit, and so full of interest in other respects, should not have received more attention from New Zealand botanists; but although it probably contains a greater number of species than any other genus of *Umbelliferae* in New Zealand our knowledge of the various forms has been of slow growth, and at present is far removed from completeness. The genus was established by the two Forsters in 1776, very shortly after Cook's second voyage, the single species collected by them being named *Aciphylla squarrosa*. In 1853, or seventy-seven years later, when Sir J. D. Hooker published his "Flora Novae-Zelandiae," *A. squarrosa* was still the only species admitted, although the plant now known as *A. Colensoi* was included in Hooker's variety *latifolia*. In the second volume of the Flora, issued two years later, *A. Monroi* was added In the first part of the Handbook, published in 1864, *A. Colensoi* was definitely separated from *A. squarrosa*, and *A. Lyallii* and *A. Dobsoni* were described, making (with *A. Monroi*) five species in all, to which a sixth was shortly afterwards added in the Chatham Islands *A. Traversii*. For many years no further additions were recorded, and attempts were even made to reduce those already published. Thus Mr. Hemsley informs me that at an early date Mr. Buchanan suggested to the Kew authorities that *A. Lyallii* should be treated as an alpine form of *A. Colensoi*, and *A. Monroi* of *A. squarrosa*. However, between 1882 and 1900 six additional species were described: two, *A. Hectori* and *A. Kirkii*, by Buchanan; three, *A. Traillii*, *A. polita*, and *A. Hookeri*, by Kirk; and one, *A. simplex*, by Petrie. In the "Manual of the New Zealand Flora," published in 1906, I have enumerated thirteen species; that is, excluding the Chatham Islands *A. Dieffenbachii*, which now constitutes the type of my genus *Coxella*, but including *A. Townsoni*, described in the appendix.

The examination of the material available during the preparation of the Manual showed quite clearly that some of the species, as understood by Hooker and others, contained more forms than one. But it was also evident that further information and more copious suites of specimens were required before reliable conclusions could be reached. Since then I have been able to settle some of the points then left undetermined, and I have also received much entirely new matter from friends. Pending the preparation of a revision of the whole of the New Zealand species, which I hope to complete before long, I have drawn up the following notes, which it seems advisable to publish at once, especially as they include descriptions of several new species and varieties.

A. Hookeri T. Kirk.

Some time subsequent to the publication of the Manual I was kindly furnished by Mr. Townson with an excellent series of specimens, which has enabled me to give a plate of the species in the recently issued "Illustrations of the New Zealand Flora." Mr. Townson has also supplied me with remarks on its distribution, from which it is evident that it has a wide range on the mountains of north-west Nelson. It probably exists on most of the higher peaks from the sources of the Heaphy and Karamea Rivers southwards along the Mount Rochfort chain, the Lyell and Brunner Mountains, and the Paparoa Range. Its altitudinal range is given as 2,500 ft. to nearly 5,000 ft.

A. indurata Cheesem. n. sp.

Affinis *A. Hookeri* T. Kirk, a qua differt caule valde majore et robustiore, foliorum segmentis multo longioribus et latioribus, non conspicue squarrosis.

Caulis robustus, erectus, 3·5–6 dm. altus, 0·75–1·5 cm. diam. Folia radicalia numerosa, 3–4 dm. longa, bipinnata; pinnis 4–6-jugis, 7–14 cm. longis, trifoliolatis; ultimis segmentis 5–12 cm. longis, 0·5–0·75 cm. latis, linearibus, planis aut leviter concavis, rigidis, coriaceis, acuminatis, apice pungentibus; marginibus valde incrassatis, serrulatis. Petioli folio aequilongi aut breviores, basi latissime vaginantes, superne rigidi, facie concavi. Bracteae numerosae, basi late vaginantes, apice pinnatae, pinnis anguste linearibus, rigidis, squarrosis, pungentibus. Umbellae numerosae, compositae, in paniculam densum angustum aggregatae. Fructus lineari-oblongus.

Hab.—South Island: Buller Valley—Mount Lyell and the Brunner Range, 3,000–5,000 ft.; Paparoa Range—Mount Bovis, alt. 3,000–4,000 ft.; *W. Townson!*

Root long, stout, tapering, often as thick as the thumb at the top. Stem stout, erect, 1¼–2 ft. high, ¼–½ in. diameter or more at the base. Radical leaves numerous, 1–1½ ft. long, pinnate with most of the pinnae trifoliolate or rarely the lowest again pinnate, the uppermost usually simple; pinnae 4–6 pairs, 3–6 in. long; ultimate segments 2–5 in. long, ⅕–⅓ in. broad, linear, occasionally squarrose but not conspicuously so, flat or slightly concave, very rigid and coriaceous, gradually narrowed into long rigid and pungent points; midrib very stout, scaberulous above; margins much thickened, cartilaginous, rough with minute serrulations. Petiole equalling or shorter than the blade, upper portion rigid and concave, below broader and sheathing and less coriaceous. Bracts very numerous, rigid, squarrose and spreading; the lower ones with a sheathing-base ½–⅔ in. broad, tipped with a pinnate leaflet 1–2 in. long; upper

gradually becoming smaller with narrower and more pungent segments; uppermost tipped with a trifid leaflet 1–1½ in. long, the segments very narrow-linear and spinous. Inflorescence compact, narrow-linear-oblong, 8–12 in. long, female slightly narrower than the male. Umbels very numerous, compound, more or less concealed within the sheathing-bracts. Fruit linear-oblong, not seen in a perfectly mature state.

This was first collected by Mr. Townson in 1904, but, unfortunately, that portion of the Manual dealing with the *Umbelliferae* had then passed through the printer's hands, so that I was unable to include it in the work. It is clearly allied to *A. Hookeri*, but is a much larger and more rigid and coriaceous plant, with the ultimate segments many times longer and considerably broader, and not conspicuously squarrose. The inflorescence is also much larger and broader, and altogether the aspect of the plant is very dissimilar. Mr. Townson's specimens from Mount Bovis are smaller, and the ultimate segments of the leaves are shorter, showing a slight approach to *A. Hookeri*.

A. oreophila Petrie. (*A. intermedia* Petrie.)

This was also gathered by Mr. Townson, on Mount Holdsworth, Tararua Range, in January, 1908, specimens of both sexes being obtained. The male inflorescence, which was not described by Petrie, is apparently not much more lax than the female. Mr. Townson remarks that it is a somewhat rare and local plant, not many examples being observed.

A. pinnatifida Petrie.

I am indebted to Mr. J. Speden, of Gore, for excellent specimens of this distinct species. He informs me that it is not uncommon at high altitudes on the mountains of south-west Otago, usually along the margins of streams or in alpine bogs. It evidently attains a greater size than given by Mr. Petrie, some of Mr. Speden's specimens being nearly a foot in height, with leaves 6–8 in. long. The female inflorescence, which is not described by Mr. Petrie, is much contracted, the umbels being almost concealed in the sheaths of the bracts. In the males the inflorescence is more open, and the sheaths of the bracts less developed. Its nearest ally is probably *A. Lyallii*.

A. Monroi Hook. f.

The original description of this species, published in the second volume of the "Flora Novae-Zelandiae" (p. 330), is much more correct than the later one given in the Handbook, which, I am informed by Mr. Hemsley, included several plants not really belonging to the species. Munro's type was discovered in 1853 in the Awatere Valley, Marlborough, on the "summit of Macrae's Run, alt. 4,500 ft." With the assistance of Mr. Hemsley, I have figured it in the recently issued "Illustrations of the New Zealand Flora" (t. 63). It will be noticed that the leaves are sparingly bipinnate at the base, which I find to be characteristic of the great majority of the specimens gathered by myself in various localities in Nelson and Canterbury, although sometimes depauperated states from high altitudes are simply pinnate. In several localities in Cant rbury, however, at moderate altitudes, I have gathered a larger and more robust plant, with the leaves uniformly pinnate, never bipinnate at the base, and with the leaflets broader and flatter. In the

Manual I included this in the circumscription of *A. Monroi*, as stated in the footnote to the description, but further study has satisfied me of its distinctness, and it is described in this paper under the name of *A. similis*.

In the Mount Cook district I have collected another allied plant which differs from the typical form of *A. Monroi* in the larger size, stouter habit, and in the leaves being more profusely bipinnate, and consequently with more numerous segments, which are rather broader and more coriaceous. Mr. Hemsley considers that it is "specifically different from the original on which the species was founded," but for the present I prefer to treat it as a variety only. It may be briefly characterized as follows:—

A. Monroi Hook. f. var. **divisa** Cheesem.

Caule robusto, foliis majoribus profuse bipinnatis, segmentis latioribus magis coriaceis.

Hab.—South Island: Mount Cook district, not uncommon in open grassy places, alt. 4,000–6,000 ft.; *T. F. C.* Mr. Hemsley informs me that there are specimens in the Kew Herbarium from other localities in the Southern Alps.

A. similis Cheesem. **n.** sp.

A. Monroi Hook. f. affinis, sed differt caule valido, foliis pinnatis nunquam bipinnatis, segmentis planis latioribus.

Herba glaberrima, 15–35 cm. alta, radice crassa. Folia radicalia 10–20, 7–25 cm. longa, regulariter pinnata, nunquam bipinnata; pinnis 4–10-jugis, 2·5–7·5 cm. longis, 2–3 mm. latis, planis, rigidis, anguste linearibus, aculeato-acuminatis, apice pungentibus. Caulis aut pedunculus validus, erectus, foliis multo longior. Umbellae compositae, in paniculam latam dispositae; bracteis late vaginantibus. Flores albi. Fructus 3 mm. longus, lineari-oblongus.

Hab.—South Island: Peaty bogs on Arthur's Pass, Canterbury Alps, alt. 3,000–4,000 ft.; also near the Waimakariri Glacier: *T. F. C.* Upper Rakaia Valley; *J. D. Enys!*

Rather stout, smooth, simple, 6–15 in. high. Leaves 10–20, outer spreading, inner suberect, 3–10 in. long, regularly pinnate, never bipinnate at the base; leaflets 4–10 pairs, 1–3 in. long, $\frac{1}{8}$–$\frac{1}{4}$ in. broad, narrow-linear, rigid, flat, striate, narrowed at the apex into a short pungent point; midrib usually evident; margins thickened and cartilaginous; sheaths smooth, flattened, furnished at the top with a rigid spine on each side $\frac{1}{2}$–1 in. long. Peduncle or flowering-stem considerably exceeding the leaves, rather stout. Male inflorescence of numerous compound umbels forming an open panicle, 2–5 in. long; bracts with broad sheathing-bases tipped with a small pinnate leaf. Rays of the primary umbels 8–15, $\frac{1}{4}$–$\frac{1}{2}$ in. long; of the secondary umbels about the same number. Flowers white. Fruit about $\frac{1}{8}$ in. long, linear-oblong. Carpels 3–5-winged.

This is one of the plants that have been confused with *A. Monroi*. But it differs from Monro's original plant, which, through the kindness of the authorities of Kew, I have been enabled to figure in the recently issued "Illustrations of the New Zealand Flora" (t. 63), in the leaves never being bipinnate, which they usually are in *A. Monroi;* in the leaflets being longer and broader and flatter, and spreading in one plane, and also in being

placed more at right angles to the primary rhachis of the leaf; in the stouter peduncle or flowering-stem; and in the more highly developed and broader sheathing-bases of the bracts. I have been acquainted with it for many years, my first specimens having been gathered on Arthur's Pass as far back as 1880. In subsequent visits I have again observed it in the same locality, and also in the vicinity of the Waimakariri Glacier.

A. multisecta Cheesem. n. sp.

A. Monroi Hook. f. affinis, sed differt caule multo robustiore, foliis numerosioribus tripinnatisectis, segmentis anguste linearibus.

Planta dense caespitosa, rigida, robusta, 20-30 cm. alta. Folia numerosa, 20–40, dense conferta, suberecta, 15-22 cm. longa; laminae 6·5-10 cm. longae, obovato-cuneatae, rigidae, coriaceae, tripinnatisectae: ultimis segmentis anguste linearibus, 2·5-3·75 cm. longis, 1 mm. latis, apice acuminatis et pungentibus. Petioli robusti, rigidi, dorso convexi, facie concavi, marginibus valde incrassatis. Vaginae 3·75–5 cm. longae, 1·75–2·5 cm. latae, superne in duas spinas laterales productae. Pedunculi robusti, foliis longiores. Umbellae compositae, in paniculam latam congestae, 8-10 cm. diam.

Hab.—South Island: Rocky places on the lower slopes of Mount Balloon, between Lake Te Anau and Milford Sound, alt. 3,500–4,500 ft.; *F. G. Gibbs!*

Densely tufted, stout and rigid, forming clumps 9 in. diameter and 9–14 in. high. Rootstock stout, sometimes divided above, clothed at the top with the remains of the old leaves. Leaves very numerous, 20-40 or even more, densely crowded, suberect, 5-9 in. in total length; lamina $2\frac{1}{2}$–4 in. long, obovate-cuneate when spread out, rigid and coriaceous, tripinnatisect; primary divisions 4–6 pairs, suberect, closely placed and partly overlapping; secondary similar but smaller and fewer; ultimate divisions very narrow-linear, 1–$1\frac{1}{2}$ in. long, $\frac{1}{20}$ in. broad, coriaceous, striate, narrowed into a short pungent point. Petiole as long or longer than the lamina, very stout and rigid, smooth and convex on the back, deeply concave in front, with the margins much thickened and rounded. Sheaths $1\frac{1}{2}$–2 in. long, $\frac{3}{4}$–1 in. broad at the base, $\frac{1}{3}$ in. broad at the top, rigid and coriaceous above, gradually becoming thin and membranous towards the base, on each side at the top produced into a stiff and rigid pungent-pointed spine 1–$1\frac{3}{4}$ in. long. Female inflorescence alone seen. Peduncle exceeding the leaves, very thick and stout, $\frac{1}{3}$–$\frac{1}{2}$ in. diameter, grooved, bearing towards the top numerous compound umbels forming a dense globose panicle 3-$3\frac{1}{2}$ in. diameter. Lower bracts 2-$2\frac{1}{4}$ in. long, composed of a broad and thin membranous sheath $\frac{1}{2}$ in. across tipped with a pinnatisect leaflet 1 in. long or more. Primary umbels 6-8, peduncles 1–$1\frac{1}{2}$ in. long; secondary umbels 6–10, bracteoles linear, undivided. Fruit $\frac{1}{6}$–$\frac{1}{8}$ in. long, linear-oblong; carpels equally 5-winged or one 4-winged and the other 5-winged.

This falls naturally into the neighbourhood of *A. Monroi*, but is easily separated from the typical form of that plant by its stouter and more rigid and coriaceous habit, by the much more finely divided leaves, with stouter rigid petioles, by the stouter peduncle and much more compact panicle. But my variety *divisa* of *A. Monroi*, described above, approaches it to some extent, although it is much less robust, and the leaves not nearly so finely divided.

A. congesta Cheesem. n. sp.

Species ad *A. Spedeni* arcte accedit, sed differt caule majore, foliis latioribus et evidenter pinnatis non flabellatis.

Robusta, 15–32 cm. diam. Folia numerosissima, 40–50, omnia radicalia, dense conferta, 9–18 cm. longa; laminis 5–10 cm. longis, breviter pinnatis; pinnis 2–4-jugis, 1 cm. latis, linearibus, rigidis et coriaceis, aculeato-acuminatis; vaginae laminis longiores, ad basi 2–5 cm. latae, supernae in duas spinas productae. Pedunculi robusti, foliis multo longiores. Umbellae compositae in paniculam globosum 9–12 cm. diam. congestae. Fructus 3 mm. longus, lineari-oblongus.

Hab.—South Island: Rocky places on the lower slopes of Mount Balloon, between Lake Te Anau and Milford Sound, alt. 3,500–4,500 ft.; *F. G. Gibbs!*

Forming large hemispherical simple or branched masses 6–12 in. diameter; rootstock often as thick as the thumb, branched at the top. Leaves very numerous, 40–50 or more, all radical and crowded round the base of the flowering-stem, the inner erect, the outer spreading, 4–8 in. in total length; lamina 2–4 in. long, pinnately divided into 2–4 pairs of leaflets with a terminal one, internodes short but evident; leaflets $\frac{1}{5}$–$\frac{1}{4}$ in. broad, linear, straight or curved, rigid and coriaceous, narrowed at the apex into a short rigid and pungent point; midrib stout; margins thick and cartilaginous; veins parallel with the midrib, but connected by transverse veinlets. Petiole or sheath usually longer than the blade, very thick and coriaceous at the top, and there $\frac{1}{2}$ in. diameter, gradually becoming membranous and broader at the base, where it is often 1–1$\frac{1}{4}$ in. across; stipules sometimes nearly as long as the leaf but usually much shorter, adnate with the petiole to the top, and so placed as to be close together on the inner face of the petiole. Peduncle or flowering-stem stout, $\frac{1}{2}$–$\frac{2}{3}$ in. diameter, about 6–12 in. high, bearing at the top a globose head 4–5 in. across of closely placed compound umbels. Lower bracts 1$\frac{1}{2}$–2 in. long; sheathing portion broad and membranous, tipped by a short pinnate leaflet. Primary umbels 6–12, secondary very numerous. Fruit linear-oblong, $\frac{1}{8}$–1 in. long; carpels 4–5-winged.

So nearly allied to *A. Spedeni* that I almost hesitate to distinguish it as a species. It differs, however, in being more robust, and in the leaves being pinnate with evident internodes between the pairs of leaflets, not flabellate with the segments spreading from one level as in *A. Spedeni*. The plant was first observed by Mr. Gibbs in 1909, but at that time barren specimens were alone seen. In January, 1914, however, Mr. Gibbs succeeded in obtaining both male and female inflorescence and mature fruit, and has furnished me with an ample series, from which the above description has been prepared.

ART. III.—*New Species of Flowering-plants.*

By T. F. CHEESEMAN, F.L.S., F.Z.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 16th December, 1914.*]

1. **Ligusticum capillifolium** Cheesem. n. sp.

Species ad *L. Haastii* Hook. f. valde accedens, sed differt primo intuito foliorum segmentis multo angustioribus.

Herba perennis, erecta, undique glaberrima, 15–22 cm. alta; radicibus fasciculatis carnosis. Folia omnia radicalia, numerosa, 10–15 cm. longa, 2·5–5·0 cm. lata, lineari-oblonga, membranacea, 2–4-pinnatisecta; segmentis ultimis anguste linearibus vel filiformibus, 4–7 mm. longis, 1 mm. latis, apicibus longe piliferis. Umbellae paucae, 1–4, compositae, 8–15-radiatae; bracteis bracteolisque lineari-subulatis. Flores albi. Fructus ovoideo-oblongus, 4–5 mm. longus; valleculae 1–2-vittatae, commissura 2–4-vittatae.

Hab.—South Island: Mountains of south-west Otago, alt. 3,000–5,500 ft.; mountains above Chalky Inlet, *A. Reischek!* Mount Tyndall, *D. Petrie!* Mount Bonpland, *H. J. Matthews!* slopes of Mount Balloon, McKinley's Pass, *F. G. Gibbs!* near Lake Harris, *J. Speden!*

Bright green, leafy, rather stout, 6–9 in. high. Roots long, stout, stringy. Leaves numerous at the base of the stem, 4–6 in. long, 1–2 in. broad; petioles short, grooved, broadly sheathing at the base; blade linear-oblong in outline, membranous, 2–4-pinnately divided, primary divisions or pinnae 8–12, the lower remote, the upper often overlapping, $\frac{1}{8}$–1 in. long, deeply and finely again divided; ultimate segments about $\frac{1}{6}$ in. long, very narrow, often under $\frac{1}{20}$ in. broad, terminating in a long flexuous hair-point. Cauline leaves absent; the flowering-stems not much exceeding the leaves. Umbels few, 1–4, compound, in an open-branched panicle; a broad sheathing-bract tipped with a short finely divided lamina at the base of each division; primary rays 8–15; involucral bracts linear-subulate, shorter than the rays. Flowers white. Fruit ovoid-oblong, $\frac{1}{6}$ in. long. Carpels usually one 5-winged and the other 4-winged; vittae 1–2 in the interspaces and 2–4 on the commissural face.

I have been acquainted with this for many years, but have delayed describing it until I could satisfy myself as to its distinctness from *L. Haastii*, to which it is very close indeed. It is, however, a smaller plant, with a flowering-stem not much exceeding the leaves; the petioles are much shorter, and the leaves much more finely cut, the ultimate segments being barely half the width of those of *L. Haastii*, and furnished with a long flexuous hair-point at the tip. Mr. Gibbs remarks that "pressed specimens badly represent the growing plant, which closely resembles in appearance a miniature *Todea superba*. The final leaflets are all turned at right angles to the plane of the leaf, giving it a beautiful mossy appearance." The first person to collect the plant appears to have been the late Mr. A. Reischek; but it has since been observed in so many stations that we may fairly conclude that it is not uncommon on the higher mountains of south-west Otago.

2. **Pterostylis Matthewsii** Cheesem. n. sp.

P. foliatae affinis, sed differt foliis rosulatis et multo numerosioribus, floribus majoribus conspicue deflexis.

Planta terrestris, robusta, glabra vel parce puberula, 8–12 cm. alta. Folia radicalia 6–8, ad basin caulis rosulata, petiolata, 2–4 cm. longa, 1–1·5 cm. lata, oblonga vel oblongo-ovata, acuta vel subacuta, ad basin truncata vel subcordata: venis conspicue reticulatis. Folia caulina (bracteae) 2, vaginata, acuta, 2–2·5 cm. longa. Flos solitarius, pro planta majusculus, conspicue deflexus, 2·5 cm. longus. Galea valde curvata; sepalo postico acuto, lateralibus usque ad dimidium fere connatis, oblique lanceolatis, breviter acuminatis. Petala falcata, lanceolata, acuminata, sepalo postico fere aequilonga. Labellum breviter unguiculatum; lamina anguste ligulata, obtusiuscula, basi appendice brevi apice lacerato-incisa donata. Columna gracilis; auriculis apice breviter acuminatis.

Hab.– North Island: Mangonui County, crest of ridge leading to Pukemiro Hill, near Kaitaia, *H. B. Matthews!*

Stout, glabrous or sparingly puberulous, 3–5 in. high. Lower leaves 6–8, rosulate at the base of the stem, petiolate, ¾–1¾ in. long, oblong or oblong-ovate, acute or subacute, truncate or almost subcordate at the base, thin and membranous; venation conspicuous, consisting of 2 or 3 parallel longitudinal veins on each side of the midrib connected by numerous transverse veinlets. Cauline leaves or bracts usually 2, erect and sheathing the greater part of the stem above the leaves, ¾–1¼ in. long, lanceolate or oblong-lanceolate, acute. Flowers solitary, large for the size of the plant, ¾–1 in. long, ½ in. broad, strongly curved outwards and downwards from the base, so that the tip becomes almost horizontal and points to the stem below the ovary. Upper sepal acute or acuminate; petals almost equal in length, falcate, lanceolate, acuminate. Lateral sepals (lower lip), connate to the middle, the free portions gradually narrowed into short filiform points embracing the galea. Lip narrow-ligulate, flat, obtuse; basal appendage short, penicillate at the tip. Column slender; auricles with an acuminate tooth at the tip.

No doubt nearly related to *P. foliata*, but easily separated by the more numerous rosulate radical leaves, which are obviously petiolate and truncate or even subcordate at the base, and by the strongly deflexed flowers. The flowers of *P. foliata* are always erect at the base, and although the upper part curves forward it never becomes deflexed to anything like the extent of *P. Matthewsii*. I have much pleasure in dedicating the plant to its zealous discoverer, who, with his father, the late Mr. R. H. Matthews, has done excellent work in investigating the orchid flora of the extreme northernmost portions of the Dominion.

3. **Pterostylis trullifolia** Hook. f. var. **gracilis** Cheesem. n. var. (Illustrations N.Z. Flora, t. 194B, left-hand figure.)

Taller and more slender than the type, sometimes 9 in. high. Radical leaves usually wanting in flowering specimens, and seldom more than 1 or 2 in barren plants. Cauline leaves narrower. Flowers smaller, ½–⅝ in. long; lobes of the lower lip shorter in proportion.

Hab.—North Island: Vicinity of Auckland, Waitakarei, and Hunua Ranges, *T. F. C.*; Thames, *J. Adams!* Kaitaia, *R. H. Matthews!*

I have been acquainted with this for many years. It probably has the same range as the type, with which it sometimes grows intermixed.

4. **Microlaena Carsei** Cheesem. n. sp.

Ab *M. avenacea* differt rhizomate tenui stolonifero vel culmos saepe e basi prostrata aut ascendenti edenti, internodiis 1 2 infimis saepe elongatis infra foliorum fasciculos sitis, panicula minus divisa rigidiore magis constricta, pedicellis brevioribus spicularum aristis brevioribus.

Hab.—North Island: Mangonui County, damp shaded places in the forest near Kaiaka, *H. Carse!*

Rhizome slender, stoloniferous. Culms slender, prostrate or ascending at the base, erect above, 6–18 in. high, smooth and glabrous, 1–3-noded, often rooting from the lower nodes and emitting fascicles of both barren and flowering shoots. Leaves short or long, 6–12 in. long, $\frac{1}{8}$–$\frac{1}{4}$ in. broad, gradually tapering to a fine point, thin, flat, glabrous, striate, faintly scaberulous on the principal veins and margins; sheaths long, smooth, compressed, strongly grooved; ligules short, thin, furnished with a few long hairs at the sides. Panicle 5–9 in. long, rarely more, compound, but much more sparingly branched than in *M. avenacea* and much narrower and more rigid, pale green; branches erect, appressed to the main rhachis, slender, angled, scaberulous. Spikelets narrow, compressed, $\frac{2}{3}$–$\frac{3}{4}$ in. long with the awns. Two lowest glumes small, many times shorter than the 3rd and 4th, not separated from them by a conspicuous interspace, the lowest $\frac{1}{3}$ the length of the 2nd, which is irregularly notched at the top; 3rd and 4th long, narrow, empty, unequal, the 4th rather more than twice the length of the 3rd, 5–7-nerved, scabrid, hairy at the base, long-awned at the tip. Flowering-glume much shorter than the 4th, acuminate but not awned, faintly 5–7-nerved. Palea linear, 1-nerved. Stamens 2.

Doubtless closely allied to *M. avenacea*, but smaller in all its parts, and with a very different habit of growth, forming open spreading patches quite unlike the dense tufts of that species. Leaves much shorter and narrower, panicle also shorter and narrower, and much less divided. The spikelets are also smaller, with shorter pedicels and much shorter awns. Dr. Stapf, of the Royal Herbarium, Kew, who has done me the favour of examining a series of specimens, considers that it is sufficiently distinct to be treated as a new species, and has kindly supplied me with the Latin diagnosis placed at the head of the description, in which he has summarized the chief points of difference between the two species. I have pleasure in associating the name of Mr. H. Carse with the plant, which he is the first to notice. For many years he has devoted much time and labour to the examination of the flora of the extreme north of New Zealand, adding many species to the list of those known to occur in the district, and making many valuable observations thereon.

ART. IV. *Descriptions of New Native Phanerogams, with other Short Notices.*

By D. PETRIE, M.A., Ph.D.

[*Read before the Auckland Institute, 16th December, 1914.*]

1. **Aciphylla Cuthbertiana** sp. nov.

Caules caespitosi 25–35 cm. alti graciles ± 3 mm. in diam. leviter canaliculati.

Folia 20–30 cm. longa longe petiolata trifoliolata v. pinnata cum foliolorum paribus duobus (raro unifoliolata); foliolis 10–15 cm. longis anguste linearibus striatis basi iterumque subaltius articulatis acuminatis subpungentibus; petiolis foliolis aequilongis ac aequilatis basi articulatis: vaginis petiolis multo brevioribus a lateribus spinas breves subulato-acuminatas edentibus.

Inflorescentia feminea ± 9 cm. longa, umbellis parvis bracteis confertis latis longiusculis vaginantibus paene absconditis: bracteis apice trifoliolatis (raro unifoliolatis).

Fructus 5 mm. longus, carpellis distincte 4–5-alatis.

Stems tufted, 25–35 cm. high, long-petiolate trifoliolate or pinnate with 2 distant pairs of leaflets (rarely unifoliolate), glabrous; leaflets 10–15 cm. long, narrow linear, striate, acuminate, subpungent, ± 2 mm. broad, jointed at the point of origin and again some distance above, midrib prominent above and channelled, edges thickened smooth, venation very obscure; petioles as wide and as long as the leaflets, above concave or nearly flat, jointed at the base; midrib little prominent; sheaths much shorter than the petioles, polished, membranous, dilated downwards, with 2 short subulate acuminate spines at the top.

Male inflorescence broadly linear-oblong; peduncles much branched, the lower long, the upper gradually shorter; lower involucral bracts leaf-like, long-sheathing, the upper simple narrowed into an acuminate tip without lateral spines. Female inflorescence short and broad, ± 9 cm. long, umbels small with sparingly branched peduncles nearly hidden by the crowded broad long-sheathing bracts that terminate in an acuminate leaflet flanked by 2 lateral linear spines or are narrowed to a single fine point.

Fruits rather large, 5 mm. long, carpels strongly 4–5-winged.

Hab.—Subalpine meadow on the mountains of Fiord County, the Hump, and End Peak; J. Crosby Smith! Mount Cleughearn; Messrs. Crosby Smith and Cuthbert!

The very narrow long rather flaccid leaves and their strongly marked articulations are ready distinguishing characters for this species. Mr. Cuthbert's services and kind assistance have made exploration in the neighbourhood of his "run" at Sunnyside a comparatively easy task.

2. **Aciphylla Crosby-Smithii** sp. nov. (preliminary notice).

This plant was collected by Mr. J. Crosby Smith in January last, at an elevation of about 5,000 ft., on Mount Cleughearn, Fiord County. It is

obviously distinct from any of the known native species, and seems most nearly related to *A. Spedeni* Cheesm. It differs from this in having rather long leafy stems closely covered by imbricating broadly cuneate coriaceous leaves, each with 3 pairs of leaflets, all nearly equalling the terminal one, and the lowermost pair somewhat remote. Above, the prominent midrib is thickened and channelled, while the margins of the glabrous pungent-pointed leaflets are yellowish and strongly thickened. The veins diverge obliquely from the midrib, forming narrow more or less oblong areoles. The flowers and fruit are still unknown, Mr. Crosby Smith having omitted to collect them, as he supposed the plant was *A. Dobsoni* Hook. f., to which it bears some resemblance in habit of growth, though otherwise very different. A fuller description is deferred until flowering specimens are obtained. Meanwhile this notice may serve to direct attention to an interesting novelty.

3. **Aciphylla cartilaginea** sp. nov.

Culmi 10 18 cm. longi e radice simplici v. ± divisa crassa elongata.

Folia omnia radicalia haud numerosa 6-9 cm. longa trifoliolata v. pinnata, foliolis 3-5 ad 3 4 cm. longis ± 3 mm. latis cartilagineis in apicem rigidum pungentem attenuatis; costa media prominente flava canaliculata, marginibus flavis incrassatis, venis obscuris a costa angulis fere paribus abeuntibus; vaginae foliis duplo breviores latae sensim deorsum dilatatae membranaceae striatae, nervis parallelis manifestis.

Inflorescentia feminea 5-7 cm. longa culmo subcrasso canaliculato recto folia plerumque excedente fulta, umbellis 5-6 confertis a bracteis breviusculis late vaginantibus ac in foliola tria longiuscula spiniformia pungentia continuatis paene absconditis.

Fructus lineari-ellipticus 3 mm. longus.

Stems 10-18 cm. high, from a simple or branched elongated tap-root as thick as the middle finger.

Leaves all radical, rather few, 6 9 cm. long, trifoliolate or more commonly pinnate with 2 pairs of leaflets and a terminal one, the lateral leaflets sometimes giving off a secondary leaflet on the outer side, stiffly cartilaginous: leaflets 3-4 cm. long, 2½-3 mm. broad, narrowed to a spinous pungent point with a conspicuous channelled yellow midrib and thickened yellow margins, veins obscure issuing from the midrib almost at right angles; sheaths half as long as the leaves, or rather more, gradually widening out below, membranous, striate, broad, with evident parallel veins.

Flowering-stems rather thin and flexuous in male plants, stouter grooved and straight in female ones; female inflorescence 5 7 cm. long, umbels 5-6 crowded small almost concealed by the rather short broadly sheathing bracts which end in 3 longish spinous pungent leaflets.

Fruit linear-elliptic, 3 mm. long.

Hab.—Wet alpine meadow of the higher hills of Stewart Island; Mount Rakiahua, P. Goyen! D. Petrie; Frazer Peaks, F. R. Chapman! G. M. Thomson! D. Petrie.

The present plant has its nearest ally in *A. Traillii* T. Kirk, to which Mr. Cheeseman refers it (Manual, p. 212). The leaves of the two species are very different, and are alone sufficient to distinguish them. The differences are partly noted in Mr. Kirk's original description of *A. Traillii*. The broad canaliculate yellow midrib, the thickened yellow margins, and

the obscure rectangular venation are characters that give it a quite distinct position. In very exposed situations the flowering-stems are greatly reduced and almost sunk among the leaves. So far as I am aware, it has not been collected on Mount Anglem.

4. **Celmisia glabrescens** sp. nov.

Species *C. glandulosae* Hk. f. affinis; differt foliis longioribus angustioribus integris infra tenuiter tomentosis, scapis elongatis glabris, capitulis majoribus ac radiis multo longioribus instructis.

Stems loosely tufted, slender, giving off lateral leafy stolons that frequently root at the base of the leafy tips.

Leaves numerous, erect or ascending, 5–9 cm. long, 1½–2 cm. broad, lanceolate-spathulate, acute, apiculate, shortly subulate-dentate at the edges, glabrous and green above, below clothed with thin appressed greyish-green tomentum, the midrib glabrous and prominent, gradually narrowed into an almost linear petiole ⅓ as long as the blade and expanding below into a broad strongly-veined sheath, venation obscurely reticulate.

Scapes as many as 4 on each branch, erect, or ascending at the base, 15–25 cm. high, striate, glabrous, slightly viscid above; bracts few, distant, linear, acute, with prominent midribs.

Heads ± 2·5 cm. across, involucral bracts in 2–3 series, linear-subulate, viscid, the outer reflexed, the inner paler and ciliate, hairy at the tips; rays numerous, narrow, spreading.

Achene silky.

Hab.—Meadow near Freshwater River, Stewart Island, 100 ft.; D. L. Poppelwell! I am indebted to Mr. Poppelwell for specimens of this species.

5. **Celmisia Poppelwellii** sp. nov.

Species *C. Haastii* Hk. f. affinis; differt foliis numerosis multo minoribus angustioribus integerrimis dense imbricatis, capitulis minoribus, scapis gracilioribus, foliorum parte petiolari quam lamina ⅓ angustiora.

Stems moderately stout, ± 10 cm. high, giving off several horizontal or ascending branches.

Leaves closely imbricating, ± 2 cm. long, 5 mm. broad, linear-sub-spathulate, rather coriaceous, acute or subacute, recurved at the edges, not toothed, suddenly expanded below the petiolar part into a broad glabrous strongly-nerved sheath with thin brown edges, above more or less plaited and covered with a rather loose pellicle of silvery-grey tomentum, clothed below with loose grey tomentum; midrib prominent below, more or less glabrous.

Scapes 1 to 3 from each branch, 8–12 cm. long, slender, more or less tomentose, bracts numerous, linear, sparingly or densely tomentose.

Heads 2–2·5 cm. across, involucral bracts in 2 or 3 series, linear-subulate, somewhat viscid; rays numerous.

Achenes glabrous.

Hab.—Subalpine meadow, on the Eyre Mountains, Central Otago; D. L. Poppelwell! I have seen only three or four specimens of this plant. Mr. J. Crosby Smith sends from Mount Cleughearn, Fiord County, what seems to be a smaller and narrower-leaved form; his specimens are not in flower.

6. **Abrotanella filiformis** sp. nov.

Minuta glabra breviter repens.

Folia pauca erecta v. ascendentia 8–12 mm. longa peranguste linearia enervia basi in vaginam striatam expansa.

Scapi gracillimi solitarii (raro bini) florigeri 5 mm. fructiferi 12 mm. longi; bracteis 4–5 brevibus peranguste linearibus.

Capitula solitaria parva 1 mm. longa ac lata; involucri squamae 8–10; flores minuti 5–6, squamas haud excedentes.

Achenia anguste fusiformia squamis fere aequilonga.

A minute shortly and loosely creeping glabrous plant giving off at intervals scattered few-leaved flowering-stems.

Leaves few, very narrow linear, 8–12 mm. long, nerveless, expanded below into a striate sheath.

Scapes solitary (rarely in twos), very slender, 5 mm. long when in flower, lengthening to 12 mm. in fruit; bracts 4–5, short, very narrow linear.

Heads solitary, small, 1 mm. long, and broad; involucral scales 8–10, shortly oblong, obtuse or sometimes subacute, greenish at the middle, with broad hyaline margins, obscurely 3-nerved; flowers minute, 5–6, not exceeding the scales.

Achenes narrow, spindle-shaped, distantly but not deeply ribbed, almost as long as the scales.

Hab.—Wet peaty puddles in open lowland moor near the head of Paterson Inlet, Stewart Island.

7. **Abrotanella Christenseni** sp. nov.

Folia rosulata 15–18 mm. longa 4 mm. juxta apicem lata anguste cuneata tenuia obtusa apice ac a parte superiore breviter dentata pilis gracillimis ex una cellularum serie constructis ± vestita; costa subtus conspicua.

Scapi complures inaequaliter provenientes erecti simplices sparse pilosi prope basim bibracteati in fructu ad 20 mm. elongati.

Capitula solitaria parva (1¼ mm. in diam.); flores numerosi minuti involucrum haud excedentes.

Achenia ad 20 1 mm. longa lineari-oblonga compressa margine ± incrassata.

Leaves radical, rosulate, 15–18 mm. long, 4 mm. broad, narrow-cuneate, thin, obtuse, shortly toothed at and near the tip, above sparsely clad with rather long slender hairs composed of a single row of cells, under-surface more glabrous except on the evident midrib.

Scapes several, erect, simple, slender, sparsely pilose, with 2 usually opposite linear bracts near the base, maturing irregularly and in fruit elongating to 15–20 mm.

Heads solitary, small (1¼ mm. in diameter); involucral bracts in two series, shortly oblong, obtuse, thin, crenately wavy at the top, the inner narrower; flowers numerous, minute, not exceeding the involucre.

Achenes 20 or fewer, 1 mm. long, linear-oblong, compressed, slightly thickened along the margin.

Hab.—Bare spots in dry fescue tussock steppe, Hanmer Plains. I have great pleasure in dedicating this curious species to its discoverer, Mr. C. Christensen, who is doing valuable work in botanical research in the Amuri

8. **Veronica cassinioides** H. J. Matthews (in litt.) sp. nov.

V. humilis erecta ramosa, ramis fastigiatis. Caules infra afoliati cicatricibus foliorum delapsorum confertis circularibus notati; rami foliosi foliis patentibus v. patulis instructi; ramuli bifariam pubescentes foliis imbricatis vestiti.

Folia decussata coriacea $\pm$ 4 mm. longa anguste lanceolata v. subtriangulari-lanceolata acute carinata supra $\pm$ convexa basi latiusculo sessilia vix connata subcompressa glabra integerrima, juniorum marginibus parce ciliatis; bracteae tenues ovatae marginibus ciliatae.

Flores spiciformi-racemosi terminales v. subterminales albi majusculi fere sessiles in paribus oppositis dispositi; calycis lobi 4, obtusi tenues ciliati, anterioribus duobus paene apicem tenus connatis; corollae tubus angustus subpilosus calycem excedens, limbus in lobos 4 latiusculos obtusos tubum aequantes sectus; stamina longe exserta; stylo stamina subaequante.

Capsula lata a dorso compressa obtusa 5–7 mm. longa calycem duplo superans, apice late emarginata.

A rather low erect shrub with numerous fastigate leafy branches, usually reddish when dried.

Stem and older branches leafless, marked by the prominent close circular scars of fallen leaves; younger branches with more or less scattered patent or spreading leaves; young shoots bifariously pubescent, clothed with close-set imbricating leaves

Leaves decussate, coriaceous, $\pm$ 4 mm. long, narrow- or subtriangular-lanceolate, acute, keeled, more or less convex above, sessile by a wide base, entire, glabrous, subcompressed, the younger sparsely ciliate at the edges; bracts thin, ovate, obtuse, with ciliate margins.

Flowers in a spike-like raceme, terminal or subterminal, white, rather large, almost sessile, arranged in opposite pairs; calyx-lobes 4, thin obtuse ciliate, the two anterior connate almost to the tips; corolla-tube narrow, subpilose, longer than the calyx, limb cut into 4 rather broad obtuse lobes as long as the tube; stamens long, exserted; style nearly equalling the stamens.

Capsule broad, dorsally compressed, glabrous, obtuse, 5–7 mm. long, twice as long as the calyx, broadly emarginate at the top, the base of the style generally persistent.

Hab.—Moist subalpine meadow, Takitimu Mountains, *fide* H. J. Matthews; Blue Lake, Garvie Mountains, 4,000 ft., D. L. Poppelwell and D. Steadman! The nearest ally of this species is *V. anomala* J. B. Armstrong.

Of this plant Dr. Cockayne writes in one of his publications, "It appears to me to be without doubt a permanent juvenile form, intermediate between the early pinnatifid and adult scale-leaved stages of the whipcord Veronicas, the adult of which is probably extinct. A closely allied plant has recently been collected by Mr. D. L. Poppelwell on the Garvie Mountains, but not in flower, and it may turn eventually into the cupressoid stage."* The Garvie Mountain plant has for some time been in cultivation at the Waikaia Public School garden, and I have well-grown specimens from there, as well as others from Mr. Poppelwell, that clearly establish their identity with Mr. Matthews's *V. cassinioides*. I know of no valid reason for Dr. Cockayne's fanciful speculations about this plant.

* Report Aust. Assoc. Adv. Sci., vol. 13, p. 219.

Its life-history is in the main well known; at no stage does it show the foliage features peculiar to the whipcord Veronicas, and its course of development is quite normal. The adult stage of the plant has been known for several years, if a plant that bears flowers and fruit, and maintains the ordinary characters of its leaves and shoots to the last unchanged, is an adult. To postulate that the adult form is probably extinct, without a shred of proof, except that flowering and fruiting plants were unknown to the writer, is wholly unwarranted. Some six or seven years ago Mr. Matthews asked me to describe this species, and supplied me with specimens in flower and fruit that had been cultivated in his garden in Dunedin. A description of it was then drawn up, but I have deferred its publication until specimens growing wild had been secured. Mr. Steadman's and Mr. Poppelwell's discovery of wild plants near the Blue Lake, Garvie Mountains, has at length removed this obstacle. It gives me peculiar pleasure to publish this species, in which my late friend took so lively an interest.

9. **Euphrasia integrifolia** sp. nov.

Caules repentes et radicantes ± 5 cm. longi glabri graciles ramos complures breves edentes.

Folia in paribus oppositis disposita 3–4 mm. longa conferta glabra integra submembranacea lineari-lanceolata acuminata basi late sessilia, venis perobscuris.

Flores pauci in foliorum superiorum axillis laxe dispositi 8–10 mm. longi subsessiles; calyx corollae tubo multo brevior campanulatus glaber in lobos 4 triangulares acutos sectus; corollae tubus sublatus, labium superius vix arcuatum late emarginatum, inferius in lobos 3 breves rotundatos sectum; antherae maturae exsertae.

Capsula (submatura) obovata calyci subaequalis compressa glabrescens acuta v. subacuta.

Semina in cellula utraque compluria, matura haud visa.

A slender creeping and rooting loosely matted plant. Stems ± 5 cm. long, glabrous, rather slender, giving off several short or moderately long branches from the axils of the lower leaves.

Leaves in opposite pairs, 3–4 mm. long, sessile by a broad base, not connate, glabrous, linear-lanceolate, acuminate, submembranous, entire, veins very obscure.

Flowers few in the axils of the upper leaves, 8–10 mm. long, nearly sessile, white with a purple streak at the back of each lobe of the corolla; calyx ½ the length of the corolla, campanulate, glabrous, shortly cut into 4 triangular acute lobes; tube of corolla rather wide, upper lip short, barely arched, broadly emarginate, lower divided into 3 short rounded lobes; anthers exserted when mature, style long.

Capsule about as long as the calyx, obovate, compressed, glabrescent, acute or subacute.

Seeds several in each cell; mature not seen.

Hab.—Wet alpine meadow and bogs on Mount Cleughearn, Fiord County, Southland, about 5,000 ft.; J. Crosby Smith!

Unfortunately, but little material of this very distinct species was secured by Messrs. Crosby Smith and Cuthbert. In no other native species

of this genus are the leaves entire. The plant has much the same look and habit of growth as *Anagosperma*, but there are certainly several young seeds in each cell, and it is likely that most of these would mature. Fresh or spirit-preserved specimens are needed to prepare a quite satisfactory analysis of the flowers and fruit.

10. **Atriplex Buchanani** T. Kirk var. **tenuicaulis** var. nov.

Culmi graciles teretes erecti v. ascendentes parum rigidi a radice longo gracili singuli v. bini v. terni v. quaterni orientes, 12–20 cm. alti, interdum apicem versus ± divisi.

Folia pauca inferne distantia superne crebriora ovato-lanceolata, quam in typo longiora ac angustiora.

Cetera ut in forma typica.

Stems slender, terete, not stiff, glabrous below, more or less farinose above, springing singly or in twos, threes, or fours from the top of the long slender root, 12–20 cm. high, sometimes sparingly subdivided towards the top.

Leaves few, distant on the lower part of the stem, closer set above, ovate-lanceolate, subacute or obtuse, usually longer and narrower than in the type.

Flowers and fruit as in the typical form.

Hab.—Moist grassy stations by the seaside. Centre Island; T. Kirk! A small island off Ototara, near Oreti mouth; J. Crosby Smith!

At first sight it is hard to realize that this form can be conspecific with the type, but the differences, which appear to be quite constant, are confined to the height, the erect slender habit of growth, and the more scattered leaves, the floral characters showing no important deviation from the type. An examination of fresh or spirit specimens might perhaps show that such differences exist.

11. **Uncinia uncinata** (L. f.) Kükenth. var. **pedicellata** (Kükenth.) Petrie var. nov.

The present variety is *Uncinia pedicellata* Kükenth., which I am unable to regard as a valid species. It is a widely spread form, marked in the Stewart Island area by a prevalent reddish-brown colouring that is usually absent elsewhere, and is probably attributable to the more or less peaty soil in which it grows there. The rather long stipitate utricles do not differ in any conspicuous way from those of *U. uncinata*, and the supposed absence in the latter of the annulation at the apex of the nut, on which Kükenthal lays so much stress in distinguishing the species, has never been observed by me in any specimen I have collected or had access to in the collections of others. The variety is chiefly distinguished by the narrow inflorescence that is frequently longer than in the typical form, the somewhat shorter glumes, and the more decidedly stipitate utricles. The plant has been well known to New Zealand botanical workers for many years, all of whom referred it to *U. australis* Pers. (= *U. uncinata*). I have it from the following localities: Kaitaia (Carse!), Tamaki West, Ruahine Mountains, Hokitika (T. Kirk!), Half-moon Bay, Catlin's River, Chatham Islands (J. S. Tennant!), and Auckland Islands (Aston!).

12. Uncinia strictissima (Kükenth.) Petrie comb. nov.

This is the plant described by me in the "Transactions of the New Zealand Institute," vol. 17, p. 271, under the name *U. rigida*. That name proved to be preoccupied, having been previously applied by Boeckeler to a species from Tristan da Cunha. I am unable to regard it as a variety of *U. rubra* Boott, a view that commends itself to Cheeseman as well as to Kükenthal. The opinions of the latter have vacillated in a remarkable way in the course of his investigation of this genus, and at one stage in their development he went so far as to place *U. rubra* Boott as a variety of *U. riparia* B. Br.

The characteristics of this plant are well set out in Cheeseman's description of his var. *rigida* of *U. rubra* Boott. The characters that separate it from *U. rubra* appear to me more decided and more constant than are those distinguishing most of the species of this difficult genus. Of these the most important are the green colour of the subaerial parts, the rather stout terete rigid culms that greatly elongate in fruiting, the rigid erect deeply grooved leaves, the constantly bracteate spikes, the bristle always shorter than the utricle, and the densely compacted rush-like tufted habit of growth.

The range of the species is now better known. It extends from the base of Jack's Pass (Amuri County) to Stewart Island, and occurs also on the Auckland Islands, where it was collected in 1890 by Mr. F. R. Chapman. Dr. L. Cockayne, F.R.S., in his "Report on the Stewart Island Flora," recognizes the plant as a valid species.

13. Carex chathamica sp. nov.

Culmi ad 6 dcm. longi erecti leves triquetri moderate robusti.

Folia culmis breviora plana 8 mm. lata levia, supra 3-nervata, subtus striata ac costa media conspicua, basi haud vaginante.

Spiculae plerumque 7 simplices, summae tres masculae sessiles confertae, reliquae femineae v. floribus paucis masculis apice instructae, pedunculatae erectae ad 6 cm. longae distantes longe vaginatae, superioribus pedunculos gradatim breviores praebentibus; bracteis longis foliosis, superioribus gradatim abbreviatis.

Glumae 6 mm. longae anguste lineari-lanceolatae acutae v. acuminatae integrae v. apice leviter bifidae membranaceae 1-nervatae.

Utriculi glumis breviores $\pm$ 3 mm. longi turgide biconvexi conspicue 2-nervati aliter enervii brunnei politi nitentes breviter stipitati, supra in rostrum breve glaberrimum subobscure bidentatum subito contracti.

Nux late ovata, supra obtuse trigona. Stigmata 3.

Culms 6 dcm. high or less, erect or inclined at the top, smooth, triquetrous, moderately stout.

Leaves shorter than the culms, flat, 8 mm. broad, smooth, slightly thickened at the edges and finely serrate towards the gradually narrowed tips, 3-nerved above, below striate with conspicuous midrib, the base not sheathing and marked off by a conspicuous oblique purplish ligule.

Spikelets usually 7 simple (very rarely with a small secondary spikelet at the base), the 3 (rarely 4) topmost male, rather slender, sessile, and closely placed, the others female or with a few male flowers at the top, erect, distant, the lowermost with long peduncles, the higher with peduncles

progressively shorter, the bottom spikelet 5–6 cm. long, ¾ cm. broad, the higher progressively shorter; bracts long, leafy, getting shorter from below upwards, with long closed sheaths nearly equalling the peduncles.

Glumes 6 mm. long, narrow linear-lanceolate, acute or acuminate, entire or slightly bifid at the tip, and produced into a short mucro, membranous, 1-nerved, yellowish or pale brown with a lighter midrib.

Utricles shorter than the glumes, 3 mm. long, turgidly biconvex, strongly 2-nerved (otherwise nerveless), dark brown, polished and shining, very shortly stipitate, suddenly contracted above into a short smooth rather obscurely bidentate beak.

Nut broadly ovate, obtusely trigonous above. Stigmata 3.

Hab. Swampy ground at Chatham Islands.

To Mr. W. R. B. Oliver I am indebted for the few over-mature specimens of this plant that have been examined. It is very distinct from the already-known native species. Mr. Oliver has the impression that it is not uncommon in swampy stations on the Chathams.

14. Carex kermadecensis sp. nov.

Folia radicalia haud visa.

Culmi (infra imperfecti) ad 6 dcm. alti moderate robusti erecti pallidi striati triquetri.

Spiculae 5–8 (forsan plures), infima longe distante simplici, superioribus plerumque ± confertis in 2–4 spiculas secundarias sessiles confertas longitudine inaequales divisis, erectae pallidae ± 5 cm. longae 6 mm. latae; supremis 3–4 mere musculis v. floribus paucis femineis apice instructis, reliquis femineis; bracteae longe vaginantes foliosae, infimis culmos valde excedentibus, superioribus cito abbreviatis.

Glumae dense confertae ovato-lanceolatae membranaceae 3-nervatae integrae v. apice bifidae, in mucronem brevem ± scabridum productae, utriculos aequantes.

Utriculi 4 mm. longi 1 mm. lati anguste elliptici breviter stipitati, supra sensim attenuati in rostrum tenue sublongum parce scabridum dentibus duobus longis tenuibus scabridis vix divergentibus instructum, leviter biconvexi nervis lateralibus duobus conspicuis ac aliis numerosis delicatulis a latere utroque praediti.

Nux elliptica aeque supra infraque contracta acute trigona ubique delicatule punctulata. Stigmata 3 (raro 2).

Radical leaves not seen.

Culms (imperfect below) 6 dcm. high or less, moderately stout, pale, smooth or slightly scabrid at the angles, striate, triquetrous.

Spikelets 5–8 or perhaps more, the lowermost long-distant and simple, the upper more or less closely placed (usually overlapping), subdivided into 2–4 secondary sessile crowded spikelets of unequal length, the lower on long slender flattened peduncles, the upper sessile or nearly so, erect, pale, 5 cm. long or less, ± 6 mm. broad, a few of the uppermost purely male or with a few female flowers at the top, the rest female; bracts long-sheathing, leafy, the lower greatly exceeding the culms, the upper rapidly shortening.

Glumes densely crowded, ovate-lanceolate, membranous, 3-nerved, pale brown with a lighter median stripe, acute, entire or bifid at the top, and

produced into a short thin more or less scabrid mucro, as long as the utricles.

Utricles 4 mm. long, 1 mm. broad, narrow elliptic, shortly stipitate, gradually narrowed above into a rather long slender slightly scabrid beak ending in 2 long slender scarcely diverging scabrid teeth, thin, flatly biconvex with two prominent lateral nerves and numerous other delicate nerves along either side.

Nut elliptic, equally narrowed above and below, sharply trigonous, delicately punctulate.

Style branches 3 (rarely 2), short.

Hab.—Denham Bay, Sunday Island, Kermadecs.

Mr. W. R. B. Oliver discovered this plant, which he has kindly placed in my hands for description. The material is imperfect, only the culms being represented. Freshly gathered specimens are needed to allow of a more accurate description of the singular inflorescence, but I hope that my account will not prove very wide of the mark. The lowermost simple spikelet may not always be present, while the compound spikelets, that are usually closely placed, are widely distant in one of the specimens examined. The plant was formerly referred to *C. Forsteri* Wahl. as subspecies *insularis* Oliver, but it does not appear to me closely related to that species, or, indeed, to any other of the native forms.

15. **Calamagrostis (Deyeuxia) Youngii** (Hook. f.) Cheesm. var. **Petriei** comb. nov.

Planta a forma typica differt arista a gluma florigera media oriente.

The present variety is the *Deyeuxia Petriei* of Cheeseman's "Manual of the New Zealand Flora" (= *Calamagrostis Petriei* Hackel). Its only important difference from the typical form is in the position of the awn, which springs from the middle of the back of the flowering-glume. Neither Hackel nor Cheeseman had seen Hooker's plant when their descriptions of *Calamagrostis (Deyeuxia) Petriei* were made out. The figures of *Deyeuxia Youngii* in Buchanan's "Indigenous Grasses of New Zealand" probably represent a form of *Deyeuxia quadriseta* R. Br., though the enlarged drawings of the spikelet may represent the real plant. Buchanan considered it a common grass in the hilly parts of southern Otago. If this was formerly the case, the plant must have been largely eaten out by stock, for it is now, I believe, quite rare in these districts.

16. **Poa Colensoi** Hook. f. var. **brevi-ligulata var. nov.**

Differt a typo ligula valde brevi v. obsoleta crassiore haud vaginante, vaginis angustioribus.

This variety differs from the typical form in possessing very short or obsolete more coriaceous non-sheathing ligules and narrower sheaths. The leaves are usually more erect and rigid and often more or less pungent-pointed, while the plants frequently form firmly compacted sward-like patches of considerable size.

In all the extant descriptions of *Poa Colensoi* the ligule is said to be very long and sheathing; as Mr. Cheeseman puts it ("Manual of New Zealand Flora," p. 908), "Ligules very large and long, sheathing, membranous, hyaline." This condition is, however, very far from constant. My col-

lection contains specimens of this grass from some twenty-five widely separated stations, and in more than half of these it is the short-liguled form that occurs. The only North Island station for this form known to me is Mount Egmont. In the South Island both forms are widely spread, but the short-liguled form seems to predominate at considerable elevations in the southern and south-western districts.

17. **Poa caespitosa** Forst. f. var. **planifolia** var. nov.

Culmi validi, florentes folia aequantes vel paullo excedentes, fructiferi ± elongati, 5-6 dcm. alti, vaginis longis scabriusculis sulcatis ad paniculi basim vestiti.

Folia plana ± coriacea a parte media 5 mm. lata, laminis glabris erectis v. ascendentibus, carina prominente.

Panicula 2-3 dcm. longa anguste ovata, ramorum longorum scabridorum complurium parce divisorum fasciculis distantibus.

Spiculae subsessiles majusculae 6 7 mm. longae, glumis ubique delicate scaberulis.

Densely tufted, forming large dark-green tussocks.

Stems stout when in flower equalling or slightly exceeding the leaves elongating more or less later, 5-6 dcm. long, clothed to the base of the panicle by the long scaberulous grooved sheaths.

Leaves on each culm rather few, blades flat, smooth, 5 mm. wide at the middle, stiff, usually coriaceous, erect or ascending, with prominent keel and numerous fine veins, edges smooth except at the tips.

Panicle 2-3 dcm. long, narrow ovate, with distant rather numerous long little-divided scabrid branches.

Spikelets nearly sessile, rather large, 6-7 mm. long, empty and flowering glumes everywhere finely scabrid; palea almost equalling the flowering-glume.

Hab.—Antipodes Island; H. J. Matthews.

I have seen only garden-grown specimens of this grass, propagated from the seed of a plant brought by Mr. Matthews from Antipodes Island. It is most likely identical with the grass which Mr. T. Kirk referred to *Poa anceps* Forst. f. (see vol. 3, p. 231, of the "Report of the Australasian Association for the Advancement of Science"). To this species it shows some approximation, but its true place seems to be in *Poa caespitosa*, a species that is known to form the principal pasture grass on Campbell Island. It is highly improbable that *Poa anceps* should extend to any of the subantarctic islands of New Zealand, as it does not range as far south as Otago, or even South Canterbury. Mr. Cheeseman has, indeed, recorded that it extends to Foveaux Strait, but this statement is most likely incorrect. I am pretty well acquainted with the vegetation of the Bluff Hill, but have never seen *Poa anceps* there. The most southerly localities for this grass known to me are the Broken River basin in North Canterbury, and Fox's River, near Brighton, in south-west Nelson. The late Mr. Buchanan at one time believed that *Poa anceps* was a common plant in Otago, and on a botanical outing with me he expressed great surprise at not meeting with it. From that time I kept a close lookout for the grass, but I have nowhere seen it south of the limits mentioned above. Dr. Cockayne did not observe it on Stewart Island.

18. Note on **Corallospartium crassicaule** (Hook. f.) Armstrong.

Mr. A. W. Roberts, of the Ranfurly State Nursery, lately sent me a packet of ripe pods of this species. Both Armstrong and Cheeseman state that the the ripe pod contains a single seed, though the latter notes that the ovules are 2–4 in number. An examination of some two dozen of the pods from the Maniototo district showed that the usual number of ripe seeds in each pod is two, three were present in a few cases, and with about equal frequency the number was one. Mr. Armstrong is probably mistaken in saying that the valves of the pod open. I have never seen any evidence of this in any of the numerous specimens that have at various time come under my notice.

19. Note on the Rediscovery of **Myosotis (Exarrhena) Lyallii** Hook. f.

This plant has not been collected since Dr. Lyall discovered it in the neighbourhood of Milford Sound, during the cruise of the surveying-ship "Acheron" in the years 1847–51. Last January, however, Messrs. Crosby Smith and Cuthbert again collected it on the shingle-faces of Mount Burns, Fiord County, at an altitude of about 5,000 ft. Their plant quite accords with the description of *M. Lyallii* in the "Flora Novae-Zelandiae." My *Myosotis oreophila* is quite unlike this species, under which Cheeseman has suggested placing it.

ART. V.—*Some Additions to the Flora of the Subantarctic Islands of New Zealand.*

By D. PETRIE, M.A., Ph.D.

[*Read before the Auckland Institute, 16th December, 1914.*]

1. **Uncinia strictissima** (Kükenthal) Petrie (*ante*, p. 55).

This species was collected in 1890 on the Auckland Islands by Mr. F. R. Chapman (now Mr. Justice Chapman), from whom I have several characteristic specimens. *U. rubra* Boott. has not as yet been found on our subantarctic islands, but their plant population is still too incompletely known for us to feel sure of its absence.

2. **Uncinia compacta** R. Br.

Mr. B. C. Aston collected some dwarf specimens of this on Campbell Island in January, 1909. They differ from the typical plant as it occurs at elevated stations in New Zealand only in having nearly sessile flowering-spikes, a condition that is practically present in a form of the species growing a little below the snow-line on the Sealey Range near Mount Cook, of which I collected a number of specimens.

3. **Uncinia australis** Pers. var. **pedicellata** (Kükenthal) Petrie comb. nov. (*ante*, p. 54).

Mr. Aston collected this on the Auckland Islands, and contributed several specimens to my collection.

4. **Uncinia Hookeri** Boott.

Kükenthal and Cheeseman refer this plant to *U. riparia* R. Br. This conclusion does not commend itself to me. Mr. Aston most kindly gave

me a fine series of specimens of the plant collected on the Auckland, Campbell, Disappointment, and Antipodes Islands, which appear to demonstrate the much closer affinity of *U. Hookeri* to *U. compacta* R. Br. than to the latter's *U. riparia*. I regard *U. Hookeri* as either a valid species or else a form of *U. rupestris* Raoul, as the late Mr. Kirk thought. What Raoul's plant really is, is still uncertain, and its rediscovery near Akaroa, where Raoul found it, will be necessary to settle the point. His figure is not characteristic of any form of *Uncinia* known to me. Botanical workers in Christchurch would do a most useful service in hunting up this species on Banks Peninsula, where it is likely still to grow.

5. **Carex Darwinii** Boott var. **urolepis** (Franch.) Kükenthal.

This species occurs on the Auckland Islands (F. R. Chapman !), and also on Antipodes Island (B. C Aston !) Mr. Chapman gave me his only specimen in February, 1890, but it was immature and not very complete, and I could make nothing of it. Some months ago Dr. Cockayne, F.R.S., gave me some pieces of *C. Darwinii* var. *urolepis* from the Chatham Islands, and Mr. W. R. B. Oliver contributed one or two more from the same locality. With this material before me I was at once able to recognize the plants collected by Mr. Chapman and Mr. Aston. I have seen only the figure of *C. Darwinii* in J. D. Hooker's "Flora Antarctica," but if that is typical of the species I would regard Franchet's species as a perfectly valid one, provided the New Zealand specimens are correctly referred there. The antiquity of this species must be immense, as it is common to South America, the Auckland and Antipodes Islands, and Chatham Islands. That species should remain stable for such vast stretches of time in environments in many respects so different may well puzzle evolutionists, and incline one to the belief that practically identical specific forms may have originated in more than one centre, a biological heresy no doubt, but one that can be supported by a large body of evidence from the New Zealand flora.

6. **Carex appressa** R. Br. var. **sectoides** Kükenthal.

This form also occurs on our subantarctic islands, having been collected by Mr. F. R. Chapman in 1890, who, however, was uncertain whether he collected it on the Snares or on the Auckland Islands, so that the exact habitat cannot be settled at present. I owe the recognition of this plant to the recent gift of specimens of it from the Chatham Islands, contributed by Dr. Cockayne, F.R.S., and Mr. W. R. B. Oliver. The occurrence together on the Chatham Islands of *C. Darwinii* var. *urolepis* and *C. appressa* var. *sectoides* lends some probability to their joint occurrence on the subantarctic islands.

It appears to be very doubtful if Kükenthal's reference of his var. *sectoides* to *C. appressa* R. Br. is warranted; the utricles differ from those of *C. appressa* more widely than do those of *C. secta*, and the points of resemblance are confined to habit of growth merely. When satisfactory material is available the position of var. *sectoides* will call for careful reconsideration.

7. **Poa caespitosa** Forst. f. var. **planifolia**.

This variety was found on Antipodes Island by the late H. J. Matthews, who brought back a live plant that grew well in his garden at Dunedin. The specimens seen came partly from this plant and partly from others grown from its "seed." As noted elsewhere (*ante*, p. 58), it is most likely identical with the Antipodes Island grass that the late Mr. Kirk referred to *Poa anceps* Forst. f.

ART. VI.—*Investigations on* Phormium.

By Miss B. D. CROSS, M.A.

[*Read before the Philosophical Institute of Canterbury, 2nd December, 1914.*]

[ABSTRACT.]

It is a remarkable fact that no one has ever attempted to make a thorough botanical study of *Phormium*, the so-called New Zealand flax, although from time to time botanists have pointed out the necessity of such an investigation on a plant of so great economic importance. The present paper is a brief abstract of a much larger thesis which records the result of my researches in 1910–11. The complete MS. has been lodged in the Dominion Museum, Wellington, where it may be consulted by any one who wishes to carry on further research on *Phormium*. The whole paper is itself only introductory, as a complete knowledge of *Phormium* can be obtained only by means of careful observations extending over several years. It must also be pointed out that my work on *Phormium* has been almost entirely from the botanical standpoint.

The following, then, is a brief outline of the paper:

HISTORICAL.

The first part is mainly historical, and deals with previously published books and pamphlets relating to the subject. Some few of these are short accounts of points of botanic interest, but for the most part they are concerned only with the qualities of New Zealand flax as a fibre-bearing plant. Although Captain Cook and Sir Joseph Banks both mention and shortly describe the New Zealand flax, the first really scientific account of *Phormium* was given by Labillardière, one of the naturalists of the expedition (1791–92) of the "Recherche" and the "Esperance" in search of the ill-fated La Perouse. Labillardière also grew the plant successfully in France, and accords it the highest praise. He says, "The flax of New Zealand holds the first place among the vegetable fibres known suitable for making rope."

Later papers deal mainly with *Phormium* from the economic standpoint. The most important of these is the work of Hector (1872), who undertook the compilation of the reports of the Commissioners who were appointed by the Government in 1869 and 1870 "to investigate and report on all matters relating to the manufacture and cultivation of New Zealand flax." This is the largest and most comprehensive work on this subject that has yet been published. It contains a good account of the cultivation of the plant and of its chemical properties, but the sections in which it is considered from a botanical standpoint must be considered very unsatisfactory.

To this historical sketch I have added a short account of the history of the flax industry and a brief outline of the chief processes concerned in the preparation of *Phormium* fibre, with the state of the industry at the present time.

The next section deals with the *Phormium* swamps and with the cultivation of the plant. It is enough to state here that *Phormium* has never been extensively cultivated in New Zealand, although it is well known

that much more fibre, and fibre of better quality, is produced from cultivated plants. This is due to the fact that millers will not make plantations while the large natural *Phormium* swamps exist.

Discussion of Specific Characters.

There has always been a certain amount of discussion with regard to the number of species in the genus *Phormium*. Hooker (1853) comes to the conclusion that there is but one species, but almost all later botanists recognize two—*P. tenax* and *P. Cookianum*. In my study of various varieties I have found that the two species cannot be absolutely separated. After carefully noting the characteristics of each variety, I attempted to put these varieties in some order, and was at once struck by the remarkable continuity of the variation. There is, indeed, a perfect chain of forms more or less closely connected, and the chain is unbroken in passing from "*tenax*" to "*Cookianum*" varieties, for "passage forms" link the two species. That this chain is real will be seen in my classification of varieties, though, no doubt, there are yet many links to be added. However, I decided to group my varieties under the two species now recognized, for the following reasons:—

In the first place, it will be seen that forms at one end of the chain are vastly different from those at the other end, and this would perhaps warrant the retention of the two specific names, though, of course, this method is wholly artificial. For this I have the authority of Hooker, who, in dividing the genus into two species, says at the same time that he considers them to be but "races of one plant." Then, again, I have made many attempts to cross-pollinate extreme forms, and have failed to obtain any results. This is certainly an additional reason for retaining the two specific names. The chief differences between two forms, one from each end of my series of varieties, may be taken as the differences between *P. tenax* and *P. Cookianum*. These are,—

(A.) *Differences in Vegetative Characters.*

I. *Habit.*—*P. tenax*, on the whole, may be said to have an erect habit, though in many varieties the leaves are more or less drooping at the tip. The fans are generally set fairly widely apart, and the leaves clasp one another very closely at the base, this being one of the reasons for the more upright habit. *P. Cookianum*, on the other hand, has a very drooping habit, the fans are more closely set, and the leaves do not clasp each other closely at the base, but fall apart at a very short distance from the base.

II. The leaves of *P. tenax* are stiff and rigid, this being the principal reason for the erect habit. They are 4–14 ft. long and 2–5½ in. broad.

(*a.*) The "*butt*," or clasping sheath-like lower portion of the leaf, is very heavy and long, sometimes being as long as the blade. Its inner surface is more or less brightly coloured, the colour varying from a faint orange-pink to a deep orange. There is generally a fairly large quantity of gum between the two halves of the butt. Very often there is a purple tinge on the outer surfaces at the base.

(*b.*) The *blade* is dark green, the lower surface being glaucous.

(1.) The *apex* is obtuse or acute, and in mature leaves the tip is split into two for several inches.

(2.) The *keel* is very much thickened on the lower surface, and is brightly coloured with a colour corresponding to that of the margins.

(3.) The *margins* are thickened, and brightly coloured orange, red, brown, and black, and there is a tendency for the colour to "run in"—that is, to extend for some distance in towards the central part of the leaf. This occurs only on the upper surface. If this is the case, the whole tip of the leaf then has the same coloration.

The *leaves* of *P. Cookianum* are much less rigid, and consequently are all drooping. They are shorter, rarely being more than 5 ft. long, and are much narrower (1–2½ in.). The edges of the leaf are inclined to curl backwards.

(*a.*) The *butt* is not so heavy, and is shorter. The inner surface is quite white, or, in rare cases, has a slight pinkish tinge, and there is very little gum.

(*b.*) The *blade* is pale green, and the lower surface is rarely glaucous.

(1.) The *apex* is acuminate, and not so inclined to split into two halves.

(2.) The *keel* is less thickened, and is of a pale-yellow colour.

(3.) The *margins* are not thickened, but are translucent, and are of a very pale yellow colour. The unthickened margins probably account for the tendency of the edges to curl outwards.

(B.) *Differences in Floristic Characters.*

III. *P. tenax* does not flower as a general rule for many years, and then generally sends up comparatively few flower-stalks; while *P. Cookianum* very often flowers long before the leaves have reached maturity, and its flower-stalks are much more abundant.

IV. The *inflorescence* (flower-stalk) of *P. tenax* is erect, stout, and tall, sometimes reaching a height of 18 ft. It is purple in colour, is glabrous, and has abundant bloom. The bracts are very large, especially those on the lower part of the stalk, and their inner surfaces are orange in colour. On cutting the stalk, sap of a deep-orange colour is expressed.

The flower-stalks of *P. Cookianum*, on the other hand, droop in all directions. They are slender, and much shorter than those of *P. tenax*, for they are rarely more than 6 ft. in height. The stalks taper much more towards the apex than do those of *P. tenax*, and there is much less bloom, and, indeed, in some it is quite absent. The bracts are smaller, and are of a yellowish-green colour on the outside and quite white within. The sap is a pale-yellow colour, and much less is expressed on cutting. The panicle of flowers is much smaller.

V. The *flower* of *P. tenax* is a dull red or an orange-red in colour, and 1–2 in. long. The three outer perianth-leaves are much deeper in colour than the three inner, which are yellow as the flower first opens, but which afterwards become a bright orange-red. They are either quite erect or slightly recurved at the tip.

The *flowers* of *P. Cookianum* are much narrower and slightly shorter than those of *P. tenax* (1–1½ in.). The three outer perianth- eaves are of a bright orange colour, and the three inner on opening are of a decided green tint, which afterwards becomes a light greenish-yellow. The inner perianth-leaves are much recurved at the tip, and are much less brittle than those of *P. tenax*.

VI. The *capsules* (seed-pods) of *P. tenax* are erect or slightly inclined, stout, trigonous, 2–4 in. long, and not twisted. In *P. Cookianum* they are long (4–7 in.), pendulous, and very much twisted.

The chief variations which have been taken into account in my classification of the varieties of *Phormium* are,—

Vegetative Characters.

I. *Habit.*—The plant may be quite erect, slightly drooping, or very drooping. The fans may be closely set together or wide apart, and the leaves of each fan again may be close together or loosely arranged.

II. The *leaves* may be rigid or quite flaccid. (It must be noted here that even if the leaves are drooping they are not necessarily flaccid. One variety, No. 9 of my list, for instance, has firm leaves, with abundant and strong fibre, and yet the leaves are drooping.) They may be dark, bright, pale, or yellow green.

(*a*.) The *butt* varies in length and in stoutness. There may be little or much "gum," and the inner surface may be white, pink, or deep orange.

(*b*.) The *blade* varies in length, width, thickness, and colour, and its inferior surface in amount of bloom.

(1.) Its *apex* may be entire, split into two along the midrib, or split into several ribbons. It may be obtuse, acute, or acuminate (tapering gradually to a point). It may be of the same colour as the rest of the blade, or coloured similarly to the margins. It may be rigid or quite soft, and may be curved inwards, straight, or curved outwards.

(2.) The *keel* varies in thickness and in colour.

(3.) The *margins* vary in thickness and in colour, the usual colours being bright orange, red, maroon, brown, and black. The margins only may be coloured, or the colour may "run in" on the upper surface, sometimes to a depth of some millimetres.

Floristic Characters.

III. *Time of Flowering.*—There is a great difference in the time of flowering of the varieties, and this appears to be constant for each variety in any one locality.

IV. *Inflorescences.*—These vary in number, colour, height, stoutness. They may be erect, slightly inclined, or inclined at various wide angles. The bracts vary in size and colour. The secondary and tertiary branches vary in length. The tip of the inflorescence may be straight or bent over.

V. The *flowers* vary in number, size, colour, and shape.

VI. The *capsules* vary perhaps more than any other part of the plant. They may be stout or slender, straight, slightly twisted, or very much twisted. It must be noted here that not only the pendulous capsules are twisted, but many which are quite erect have a decided twist.

Classification.

As I have stated above, I have retained the two specific names—*P. tenax* and *P. Cookianum*. *P. tenax* I have divided into five groups, which are again subdivided into a number of varieties which I have simply numbered, since names might cause confusion. There are twenty-five of these varieties included in *P. tenax*. Then follow five varieties which are considered as forms intermediate between the two species, and finally eight varieties of *P. Cookianum* which are included in one group.

The larger groups have been classified mainly according to habit, while varieties are distinguished mainly by floristic characters, though vegetative characters have not been neglected.

The following is a brief outline of the classification :- -

Phormium tenax.

Group A (seven varieties).

I. ***Habit***, erect ; fans well separated.
II. ***Leaves***, light green, rigid : butt only slightly reddish : margin narrow, distinct, and thickened.
IV. ***Inflorescences***, erect, stout, straight.
V. ***Flower***, dark red.
VI. ***Capsules***, erect, stout, straight.

Group B (three varieties).

I. ***Habit***, inner leaves erect, outer drooping.
II. ***Leaves***, light green, rigid, very wide, shorter than those of A ; butt very red ; margin "running in."
IV. ***Inflorescences***, more numerous than those of A, stout, straight.
V. ***Flowers***, darker red than in A.
VI. ***Capsules***, very numerous, erect, stout, straight.

Group C (four varieties).

I. ***Habit***, drooping, especially outer leaves ; fans more closely set.
II. ***Leaves***, dark green, not rigid ; margins narrow, distinct, and thickened ; butt of medium redness.
IV. ***Inflorescences***, numerous, tapering scorpioid, falling in all directions.
V. ***Flowers***, dark red.
VI. ***Capsules***, inclined at various angles, straight and narrow.

Group D (ten varieties).

I. ***Habit***, erect ; fans closely set.
II. ***Leaves***, very narrow and rigid : butt of medium redness.
IV. ***Inflorescences***, few, erect, short and straight.
V. ***Flowers***, dark red.
VI. ***Capsules***, erect, short, straight, flattened on top.

Group E (three varieties).

I. ***Habit***, drooping ; fans closely set.
II. ***Leaves***, long and wide ; margins narrow, distinct, and thickened ; butt of medium redness.
IV. ***Inflorescences***, numerous, spreading in all directions, straight, tapering, and somewhat slender.
V. ***Flowers***, bright red or yellowish red.
VI. ***Capsules***, erect, long, narrow, generally slightly twisted.

Gradation Forms.

Group F (five varieties).

I. ***Habit***, fairly erect ; fans closely set.
II. ***Leaves***, light green, narrow, thin, and flaccid ; margins narrow, distinct, unthickened, and inclined to curl backwards ; butt of medium redness.
IV. ***Inflorescences***, numerous, short, erect, and slender.
V. ***Flowers***, dark red.
VI. ***Capsules***, stout, short, erect, straight or twisted.

Phormium Cookianum.

Group G (eight varieties).

I. *Habit*, very drooping; fans closely set.

II. *Leaves*, pale green, narrow, short, thin, flaccid; margins translucent pale yellow, unthickened; leaves curl backwards; butt white, short, little gum.

IV. *Inflorescences*, numerous, short, tapering, drooping in all directions, stalk sometimes green.

V. *Flowers*, short, yellow, inner perianth-leaves much recurved at tip.

VI. *Capsules*, long (4–7 in.), pendulous, and very twisted.

Development.

After the classification follows a fairly long account of the development of *Phormium*. This includes descriptions of the anatomy of various parts of the young plant at successive stages in its development. It ends with a full anatomical account of the mature leaf. This chapter is illustrated with drawings of sections of different parts of the leaf.

Pollination.

My experiments in pollination were carried out with as much care as possible, but it is well known that mistakes easily occur in these experiments, and I hope to verify my statements at a later date. In my paper I have stated that as the result of my investigations I have found—(1) That *Phormium* is *not* self-fertile; (2) extreme forms of *P. tenax* and *P. Cookianum* cannot be crossed; (3) cross-pollination is easily effected between varieties which are closely related.

The Diseases of Phormium.

The main diseases are merely shortly described, as they would form a large subject for research. I have appended a list of varieties which exhibit ability to resist fungus diseases.

The Fibre.

This section includes a description of the fibre-content of the varieties, with a table of the measurements of the diameter of the fibre and the cavity for each variety. It also gives an account of experiments on the expansion and contraction of the fibre of New Zealand flax and manila hemp.

When explaining the principles followed in the classification I have stated that the Maori system was entirely artificial, since it was based on one character only, and that a character of slight botanical importance—namely, the quality of fibre. After I had arranged my varieties in their groups I sent leaves of all the varieties to be milled and graded, and was surprised to find that almost all the varieties of each group fell into the same grade.

The remainder of the paper is concerned with general conclusions and with a full bibliography of works dealing with *Phormium*. In addition to the MS. there is a fairly large set of plates and photographs illustrating the chief statements made in the text.

ART. VII.—*Plant-habitats Hitherto Unrecorded.**

By B. C. ASTON, F.I.C., F.C.S.

[*Read before the Wellington Philosophical Society, 28th October, 1914.*]

Lepidium tenuicaule T. K. Wharekahu Bay, Kapiti Island.
—— —— var. *minor* Cheesem. Near trig. station on Kapiti Island.
Hymenanthera crassifolia Hook. f. On littoral rocks, Kapiti Island, and Motungarara Island.
—— *obovata* T. K. On coastal crags near Toepiro Stream, Kapiti Island, at Somes Island, and at Seatoun Heads.
Pittosporum cornifolium A. Cunn. Epiphytic on forest-trees, west side Kapiti Island.
Eleocarpus dentatus Vahl. In forest, Wharekahu Bay, Kapiti Island.
Pelargonium australe Jacq. Motungarara Island, near Kapiti Island.
Eugenia maire A. Cunn. In swampy parts, Wharekahu Bay, Kapiti Island.
Epilobium alsinioides A. Cunn. On cliffs, west side Kapiti Island.
Fuchsia excorticata Linn. f. Waterfall Creek, Kapiti Island.
Tetragonia trigyna Banks & Sol. Motungarara Island and Kapiti Island.
Daucus brachiatus Sieb. On coastal cliff-faces, Kapiti Island.
Coprosma lucida Forst. Waterfall Creek, Kapiti Island.
—— *Cunninghamii* Hook. f. Tokamapuna Island, near Kapiti Island.
—— *rotundifolia* Hook. f. Kapiti Island.
—— *propinqua* A. Cunn. Common on Kapiti Island.
—— *foetidissima* Forst. On higher parts of Kapiti Island.
—— *Colensoi* Hook. f. In bush, Waterfall Creek, Kapiti Island.
Nertera setulosa Hook. f. Highest parts of grass uplands, Kapiti Island.
Galium umbrosum Sol. On western cliffs, Kapiti Island.
Erechtites arguta D.C. Kapiti Island.
—— *scaberula* Hook. f. Motungarara Island, near Kapiti Island.
Senecio Kirkii Hook. f. In high forest, Kapiti Island.
Wahlenbergia gracilis A. D.C. Kapiti Island.
—— *saxicola* A. D.C. Kapiti Island and Motungarara Island.
Olea lanceolata Hook. f. Waterfall Creek, Kapiti Island.
Dichondra brevifolia Buch. Motungarara Island and Kapiti Island.
Solanum nigrum Linn. Growing on beach, Kapiti Island.
Veronica macroura Hook. f. var. *Cookiana*, Cheesem. Coastal parts Kapiti Island.
—— *parviflora* Vahl. Edge of bush on high country, Kapiti Island.
—— *leiophylla* Cheesem. Shores of Cook Strait, between Island Bay and Terawhiti.
Muehlenbeckia ephedrioides Hook. f. Cawthron Park, Nelson; near Seatoun Heads, Wellington, Dr. L. Cockayne and B. C. A.
Litsaea calicaris Benth. & Hook. f. Te Kuiti, B. C. A.; Mokau, E. P. Turner.
Knightia excelsa R. Br. Wharekahu Bay, Kapiti Island.

* The information relating to the Kapiti Island habitats was obtained during a three days' visit to that island with Mr. E. Phillips Turner, F.R.G.S., in January, 1912. To him and to Mr. and Mrs. Bennett, our hosts, are my best thanks due for a most enjoyable excursion. Much help and enjoyment was derived on the island from a study of the "Report on a Botanical Survey of Kapiti Island," by Dr. L. Cockayne, F.R.S. (1907), who was, unfortunately, unable to visit a portion of the island for lack of a boat. The time of his visit was October, and therefore rather early for recognizing many plants with certainty. Our visit was in these respects more opportune.

Urtica incisa Poir. Kapiti Island.
Parietaria debilis Forst. In damp ground, Kapiti Island.
Dendrobium Cunninghamii Lindl. On forest-trees, Kapiti Island.
Earina mucronata Lindl. Waterfall Creek, Kapiti Island.
Thelymitra uniflora Hook. f. Kapiti Island.
Pterostylis australis Hook. f. Wharekahu Bay, Kapiti Island.
Caladenia minor Hook. f. On high spurs, Kapiti Island.
Chiloglottis cornuta Hook. f. In high forest, Kapiti Island.
Gastrodia Cunninghamii Hook. f. In forest, Kapiti Island.
Phormium tenax Forst. Motungarara Island, near Kapiti Island.
Juncus pallidus R. Br. Kapiti Island.
Gahnia pauciflora T. K. In forest, Kapiti Island.
Carex pumila Thunb. Motungarara Island.
Microlena stipoides R. Br. Forms a sward on the high levels, Kapiti Island.
Deyeuxia Forsteri Kunth. Kapiti Island.
—— *Billardieri* Kunth. Kapiti Island.
Poa caespitosa Forst. Wharekahu Bay, Kapiti Island, and Motungarara Island.
—— *imbecilla* Forst. Among upland scrub, Kapiti Island.
Atropis stricta Hack. Motungarara Island and Kapiti Island.

Unrecorded Filices and Lycopodiaceae at Kapiti Island.

Hymenophyllum multifidum Swartz.
—— *subtilissimum* Kunze.
Trichomanes venosum R. Br.
Asplenium flabellifolium Cav.
Nephrodium decompositum R. Br.
—— *glabellum* A. Cunn.
—— *hispidum* Hook.
Polypodium australe Mett.
—— *grammitidis* R. Br.
—— *Cunninghamii* Hook.
Tmesipteris tannensis Bernh.

Indigenous Plants of the Ruahine and Kaimanawa Mountains.*

Ranunculus lappaceus Smith. Ruahine Mountains.
—— *rivularis* Banks & Sol. Ruahine Mountains.
Clematis indivisa Willd. Taruarau River Gorge, Kaimanawa Mountains.
—— *parviflora* A. Cunn. Whisker's Bush, Feilding.
Caltha novae-zealandiae Hook. f. Mount Makorako, Kaimanawa Mountains; 5,000 ft.
Hymenanthera crassifolia Hook. f. On limestone country, west side of Ruahine Mountains; 3,000 ft.
Melicytus micranthus Hook. f. West face of Ruahine Mountains, on Rangitikei River; 1,650 ft.
—— *ramiflorus* Forst. Taruarau River Gorge, Kaimanawa Mountains.
Pittosporum Ralphii T. Kirk. Boyd's Bush, near Kuripapanga, Kaimanawa Mountains.
—— *tenuifolium* Banks & Sol. Boyd's Bush.
Plagianthus betulinus A. Cunn. West face of Ruahine Range; 1,800 ft.

* This list is supplementary to that given in my paper in Trans. N.Z. Inst., vol. 46, p. 43, 1914.

Hoheria populnea A. Cunn. Taruarau River Gorge, Kaimanawa Mountains.
Geranium dissectum Linn. var. *australe* Benth. West face of Ruahine Mountains.
Geum leiospermum Petrie. Reporoa bog, Ruahine Mountains; 3,000 ft. Now recorded for the first time in the North Island.
Drosera spathulata Labill. Reporoa bog, Ruahine Mountains; 3,000 ft.
Leptospermum ericoides A. Rich. Taruarau River Gorge, Kaimanawa Mountains.
Oreomyrrhis andicola Endl. Mount Makorako, Kaimanawa Mountains; 5,700 ft.
Aciphylla squarrosa Forst. West face of Ruahine Mountains; 1,500 ft.
——— var. *minor*. Reporoa swamp.
Coprosma grandifolia Hook. f. Boyd's Bush, Kaimanawa Mountains.
Panax anomalum Hook. Limestone country on Mount Aorangi, Ruahine Mountains.
— *arboreum* Forst. Taruarau River, Kaimanawa Mountains.
Coprosma lucida Forst. Boyd's Bush, Kaimanawa Mountains.
— *Cunninghamii* Hook. f. West side of Ruahine Mountains; 1,800 ft.
— *rhamnoides* A. Cunn. Boyd's Bush, Kaimanawa Mountains.
— *crassifolia* Col. Taruarau River Gorge, Kaimanawa Mountains.
— *rotundifolia* Hook. f. West side of Ruahine Mountains; 1,800 ft.
— *rubra* Petrie. West side of Ruahine Mountains; 1,700 ft.
— *acerosa* A. Cunn. Taruarau River Gorge, Kaimanawa Mountains, Ruahine Mountains.
Asperula perpusilla Hook. f. Reporoa bog, west side of Ruahine Mountains; 3,000 ft.
Brachycome odorata Hook. f. Kaimanawa Mountains.
Lagenophora Forsteri D.C. West side of Ruahine Mountains.
Olearia nummularifolia Hook. f. Mount Otupae, Ruahine Mountains.
— *furfuracea* Hook. f. Mount Otupae, Ruahine Mountains.
Gnaphalium subrigidum Col. 3,800 ft. on Mount Aorangi, Ruahine Mountains.
— *Traversii* Hook. f. Kaimanawa Mountains.
Erechtites prenanthoides D.C. Taruarau River Gorge, Kaimanawa Mountains.
— *quadridentata* D.C. Taruarau River Gorge, Kaimanawa Mountains.
Senecio Colensoi Hook. f. Taruarau River Gorge, Kaimanawa Mountains.
Microseris Forsteri Hook. f. Ruahine Mountains.
Taraxacum officinale Wigg. Ruahine Mountains.
Phyllachne Colensoi Berggr. Mount Makorako, Kaimanawa Mountains; 5,700 ft.
Myrsine Urvillei A. D.C. Taruarau River Gorge, Kaimanawa Mountains.
Myosotis eximia Petrie, MS. On limestone scarps and talus slopes. Mounts Aorangi, 3,800 ft., and Mangaohane, 3,600 ft., Ruahine Mountains.
Calystegia tuguriorum R. Br. West side of Ruahine Mountains; 1,650 ft.
Plantago uniflora Hook. f. Upper Taruarau River, Kaimanawa Mountains.
Scleranthus biflorus Hook. f. Mount Aorangi, Ruahine Mountains; 3,800 ft.
Pimelea longifolia Banks & Sol. Taruarau River Gorge, Kaimanawa Mountains.
Tupeia antarctica Cham. & Schl. On *Pittosporum tenuifolium*, Mount Aorangi, Ruahine Mountains.
Australina pusilla Gaud. Mount Aorangi, Ruahine Mountains
Podocarpus ferrugineus D. Don. Boyd's Bush, Kaimanawa Mountains.

Podocarpus spicatus R. Br. Boyd's Bush, Kaimanawa Mountains.
Dacrydium cupressinum Sol. Boyd's Bush, Kaimanawa Mountains.
Earina autumnalis Hook. f. Tukutuki River, Ruahine Mountains.
Microtis porrifolia R. Br. Ruahine Mountains, Kaimanawa Mountains.
Phormium Cookianum Le Jolis. Taruarau River, Kaimanawa Mountains.
Herpolirion novae-zealandiae Hook. f. Reporoa bog, Ruahine Mountains; 3,000 ft.
Luzula Colensoi Hook. f. Mount Makorako, Kaimanawa Mountains; 5,000 ft.
Typha angustifolia Linn. Taruarau River.
Cladium Sinclairii Hook. f. Taruarau River Gorge, Kaimanawa Mountains.
—— *Vauthiera* C. B. Clarke. Taruarau River.
Echinopogon ovatus Beauv. Taruarau River Gorge, Kaimanawa Mountains.
Deyeuxia Forsteri Kunth. Taruarau River Gorge, Kaimanawa Mountains.
—— *setifolia* Hook. f. Parke's Peak, near Makaretu, Ruahine Mountains, 4,000 ft.
Dichelachne crinita Hook. f. Taruarau River Gorge, Kaimanawa Mountains.
Koeleria Kurtzii Hack. Mount Makorako, Kaimanawa Mountains. Now for the first time recorded in the North Island.
Poa imbecilla Forst. Mount Makorako, Kaimanawa Mountains; 4,000 ft.
Agropyrum scabrum Beauv. Mount Aorangi, 3,900 ft., Ruahine Mountains; Taruarau River, Kaimanawa Mountains.

Art. VIII.—*Notes on Comparatively Recent Changes in the Vegetation of the Taupo District.*

By the Rev. H. J. Fletcher.

[*Read before the Wellington Philosophical Society, 28th October, 1914.*]

In separate publications, from the time of Bidwill's "Rambles in New Zealand" (published in 1841, although written in 1839) right up to the present time, Taupo has had its share of notice; but, as far as I am aware, no one has written about the changes that have taken place in the appearance of the country at the northern end of Lake Taupo during recent times.

There is a popular delusion abroad that an eruption of red-hot pumice from some centre not specified destroyed most of the vegetation around Taupo, with the exception of some of the isolated patches of forest such as may be seen at Opepe, Oruanui, Tauhara, and many other places. I wish to show in the following notes that the forest at one time covered the whole of the country around the lake, and that the forest has been destroyed by human agency; and, further, to show that there has been no great change in the configuration of the Taupo country for many centuries.

The Taupo country at the present time, with the exception of the patches of bush mentioned above, is covered with what is popularly called scrub, tussock, and fern. The scrub is mainly composed of *Leptospermum scoparium*, *Leptospermum ericoides*, *Coriaria ruscifolia*, *Styphelia acerosa*, *Gaultheria*, and *Dracophyllum*. Of these, the *Leptospermum scoparium* and *Leptospermum ericoides* form the main growth, with the *Styphelia acerosa* and *Gaultheria* forming thick matted growths among them. The *Coriaria ruscifolia* grows in among the other scrub in clumps, and is noticeable for miles over the landscape by its dark-green foliage showing above the lighter green of the *Leptospermum scoparium* and *Leptospermum ericoides*. The

Dracophyllum has some large areas all to itself, but it is also found in single plants among the other scrub. The tussock is fast disappearing; it is giving place to *Leptospermum scoparium* and *Leptospermum ericoides*. The common fern or bracken (*Pteris aquilina*) grows on the edge of the patches of forest in a thick rank growth, in gullies, and on the hillsides with *Leptospermum*.

The country has changed very much in appearance during the past few years. Thirty years ago the greater part of the land to the north and east of the Taupo Township was covered with tussock. When fires destroyed the tussock a growth of *Leptospermum* sprang up in its place and increased so rapidly that now it is hard to realize that where the *Leptospermum* now blooms the tussock once held undisputed sway.

This change is one of the cycle of changes now going on. If the *Leptospermum* escapes the ravages of fire for any period above fifteen years, the beginnings of forest growth are seen in the young *Coprosma*, *Pittosporum*, and *Nothopanax* taking advantage of the shelter afforded by the *Leptospermum* to obtain a start in life. These three families of plants are the forerunners of others, and where the scrub escapes the ravages of fire for a lengthy period nature is hastening to reclothe the country with its ancient forest. I use the term "reclothe" because within the memory of men still living the old forests extended over a much greater area than at present. There is an old Maori now living at Oruanui who remembers the time when the Oruanui Forest extended right on to the edge of the Taupo Lake at Rangatira. The proof of this was to be seen all over that portion of the country up to the last few years. The remains of the burnt logs, mostly *Podocarpus totara*, were collected by the European residents of Taupo, and used as firewood. The last load, as far as I know, was brought in in 1895; but in the more secluded gullies, and where they have escaped the frequent fires, they are still to be seen. Mr. T. McKinley, who has a pastoral lease over a portion of the country mentioned above, has used nothing else for fencing-posts than the old charred *Podocarpus totara* logs.

A short time before his death, in 1900, an old Taupo Maori named Tahau told me that in the days of his grandfather the clumps of forest now known as Opepe, Motukino, and Tauhara were all connected, and extended over a very large area. It extended out towards the Rangitaiki, the source of the Pueto, the Waikato River, between the present Township of Taupo and the Aratiatia Rapids, and on to the Taupo Lake at Wharewaka. The evidence of this is to be found in the remains of totara logs over all the country mentioned. The old man was between seventy-five and eighty years of age when he died, and if we reckon the boyhood of his grandfather at fifty years prior to his own birth it gives a period of 125 years back from 1900 to the existence of this extensive tract of forest. On the strength of the positive evidence here given we cannot resist the conclusion that in other parts of the Taupo country where the burnt logs are found they must be taken as conclusive evidence of the existence of forest there within very recent times.

The destruction of the forest came about in a very simple way. The staple food of the Taupo Maoris in pre-pakeha days was fern-root, the rhizome of *Pteris aquilina*. Great quantities of this starchy root was dug up in its proper season every year and stored for use. The best fern-root grew on freshly burnt bush country, and to provide this they were in the habit of burning fresh patches of bush as required. They were accustomed to break down the light scrub and burn it when sufficiently dry. The

fires would destroy the standing timber, and would often spread much farther than intended. In this way the large forests of the Taupo country have been reduced to their present dimensions. These forests can be taken as sufficient to show that no great change has taken place in the surface configuration of Taupo during their time of growth. And as it is usually admitted that the New Zealand forest growth is very slow, it is not too much to place the beginning of the forest at over a thousand years ago.

Up to this point we are on firm ground, but how much further back than the date given above to the beginnings of forest growth it is impossible to determine. The Maori occupation of the country around the lake prior to the time of Ngatoroirangi. Tia, and others of the Arawa people is extremely doubtful; and no other evidence beyond theirs is known to exist.

The forest gives no indication of many generations of large trees. The shallowness of the humus in the forest will not admit of the idea of the decay of generations of the larger forest-trees, and the contours of the country are so sharp that it is quite evident the change from one deposit of pumice to a covering of some kind must have been very rapid. Perhaps the order of change was the same as we have given above—fern, tussock, scrub, forest.

Beneath the surface pumice for several miles around the Township of Taupo there is a deposit of volcanic mud, very much like the mud from the eruption of Tarawera in 1886. This mud can be traced in all the road-cuttings leading out from Taupo. On the old Atiamuri Road from Taupo via Oruanui it appears in every cutting, low down in the valleys as well as high up on the hills. It is very noticeable on both sides of the Waikato River near the bridge at Taupo. Beyond Oruanui, on the Mokai Road, it is seen for only a short distance, not quite two miles from Oruanui. On the Rotorua Road, via Wairakei, it can be found for over six miles beyond Wairakei. On the Napier Road it can be traced from the edge of the Taupo Lake to Opepe. The deposit is not found at more than 7 ft. below the surface, except near the edge of the lake, and in many places it is only a few inches. The average depth may be reckoned at 3 ft.

The existence of this stratum of mud at such a depth shows that the surface configuration of the country was almost the same prior to the eruption as it is now.

The source of the mud seems to have been some point near the explosion craters at Rotokawa, the deposit, as far as can be traced, having somewhere about the same thickness at points equally distant from that centre—Taupo, Wairakei, and the hills above the Aratiatia Rapids on the western side having about the same thickness of mud; Oruanui much less; and still farther away from Rotokawa it is not found for more than two miles on the Mokai Road.

There are other questions connected with the age and appearance of the country that the writer does not feel competent to deal with. For instance, the streak of mud we have mentioned appears low down near the present level of the lake, and at least 800 ft. above it. Yet the terraces which mark old lake-levels are formed in the pumice which is on top of the mud. This is very noticeable in the case of the terrace at 120 ft. above the present level. This seems to indicate that when the mud was deposited the surface features were almost the same as at present; that a lake was formed and rose to a considerable height above the present level—how high we cannot at present determine: and that the lake gradually receded, leaving terrace formations, more or less distinct, until it reached its present level.

ART. IX.—*Preliminary Note on the Protocorm* of Lycopodium laterale *R. Br. Prodr.*

By J. E. HOLLOWAY, M.Sc.

[*Read before the Philosophical Institute of Canterbury, 2nd December, 1914.*]

IT is well known that in the embryo plant of *Lycopodium cernuum*, and also in those of *L. inundatum* and *L. salakense*, the development of the tuberous organ termed the "protocorm" is an important phase in the ontogeny, bridging over the period between the early stage in which the embryo plant is wholly dependent upon its parent prothallus, and its subsequent development, in which it has obtained independence through the establishment of a root-system. Moreover, in the related genus, *Phylloglossum*, a protocorm is present, and this plant has been spoken of as "a permanently embryonic form of Lycopod," for the protocorm is there not a temporary organ, but the plant-body proper.

The Lycopod protocorm is the subject of widely differing interpretations. The first of these, and one which invests this organ with considerable interest and importance, is that it is a highly primitive organ, and represents an ancestral phase in the evolution of the free-living *Lycopodium* sporophyte, and perhaps also in the evolution of vascular plants generally (Treub). A second interpretation is that the protocorm is not to be regarded so much a primitive organ as an opportunist growth, and that, even if it does play an important part in the establishment of certain Lycopod embryos, it is not to be regarded as representing a phylogenetic feature in the *Lycopodiaceae*, and still less in vascular plants as a whole (Bower). A third interpretation has more recently been put forward, which, taking into account the great development of the stem in Palaeozoic Lycopods, and being unwilling to regard the protocorm either as a highly primitive organ or as a mere parenchymatous swelling, would look upon it as a modified form of stem due to reduction (Brown, "New Phytologist," vol. 12, p. 222, June, 1913).

In view, therefore, of the puzzling nature of this organ, it is interesting to note that it has been found in yet another species of *Lycopodium*— viz., *L. laterale*—and that it there assumes a much greater size, and plays a much more important part in the establishment of the young plant than in the other species of *Lycopodium* in which it has been recorded.

In a paper entitled "A Comparative Study of the Anatomy of Six New Zealand Species of *Lycopodium*" published in the Transactions of the New Zealand Institute, vol. 42, 1910, the writer gave a short account of the protocorm of *L. laterale*, with five small figures (figs. 5–9, pl. xxxi). No definite conclusion was there reached as to the interpretation of the protocorm. The present paper is a summary of the writer's further observations upon this organ.

The prothallus of *L. laterale* is of the *cernuum* type, as is the case also for the prothalli of each of the other species in which a protocorm has been found, excluding the possibly doubtful case of *L. phlegmaria*. At the stage at which the young plant of *L. laterale* consists of a basal protocorm surrounded by two or three protophylls it is similar in appearance to the young plant of *L. cernuum*. The succeeding stages in its development are, however, noteworthy. The protocorm grows sideways, owing to the lateral development of two new protophylls, whose swollen

bases, in the majority of young plants of this age that were examined, show as a tuberous region separated from the first-formed protocorm proper by a more or less marked constriction. In *L. cernuum* the protophylls are all normally developed on the upper side of the small tuberous protocorm, and not as a lateral extension of it. The writer has, however, out of a large number of young plants of *L. cernuum* that he has examined, observed that the protocorm in one or two instances showed a distinct tendency to grow laterally, one young plant showing seven protophylls on such an extended protocorm. In older plants of *L. laterale* it was observed that the original protocorm could often be still distinguished from the later-formed protocormous extension, and that the former easily broke away from the latter in the process of cleaning.

The further growth of the young plant takes place by the continued lateral development of protophylls, and the consequent extension of the protocorm by their swollen bases, the protocorm increasing in thickness the farther from the original end. The protophylls are more or less arranged in two rows on its dorsal surface, this arrangement indicating that their development, as also that of the rhizome itself, has taken place very regularly. The protocormous rhizome thus formed bears ventrally a mat of rhizoids. It gradually loses its green colour and semitranslucent appearance, and in the fully developed stage has become yellowish and opaque and firm, whilst after the differentiation of the stem-axis both the protophylls and the rhizoids decay away. The rhizome consists of parenchymatous tissue throughout, the cells of the central region being smaller and more compact, whilst those nearer the surface are larger, and show air-spaces. A strand of vascular tissue is present in each protophyll, and passes down into the body of the rhizome, where it ends blindly. At the stage at which a stem-apex is differentiated there are from eight to twelve protophylls, and the rhizome is from 3 mm. to 5 mm. in length and from 1 mm. to 2 mm. in thickness. In one instance it was observed that the rhizome had forked into two equal branches, and that on each of these a stem was developing.

The stem-axis arises at some point on the dorsal surface of the rhizome towards its growing end, or even almost at the end itself, and is indicated by the aggregation of protophylls. At the same time, vascular tissues are initiated from the stem-apex and extend down into the body of the rhizome, receiving on the way strands from the neighbouring protophylls. In the rhizome these vascular tissues bend round at a sharp angle, and, surrounded by a slight zone of sclerenchyma, take a course through the body of the rhizome, though nearer its dorsal surface, towards its growing end. The latter at the same time grows outwards and downwards to form a finger-like protuberance into which the vascular tissues pass. Thus the extension in length of the protocormous rhizome is brought to a close by the initiation of this exogenously developed first root. The writer has observed that in the young plant of *L. cernuum* the vascular tissues of the stem behave in the same way as in *L. laterale*. They lead down bodily into the upper region of the protocorm, and thence decline towards the finger-like protuberance of the rhizome, which is the first root, though in this species the angle of declination is more gradual than in *L. laterale*. The course of the main vascular strand in its relation to the protocorm just described may be compared with what obtains in the young plant of *L. clavatum* and other species, where the vascular system does not extend into the tissues of the large intraprothallial foot. All subsequently formed roots in the young plants of both *L. laterale* and *L. cernuum* emerge

adventitiously from the stem, and do not pass through the tissues of the protocorm. The protocormous rhizome of *L. laterale* is a persistent organ, and may be recognized in plants 2 in. or even more in height. It may be stated that the protophylls both on the protocorm proper and on the rhizome are essentially similar in appearance and structure to the ordinary vegetative leaves borne on the young stem-axis. In no case either in *L. laterale* or in *L. cernuum* was any transition between them to be observed.

L. laterale grows on damp peaty ground and around the margins of marshes. *L. cernuum* and *Phylloglossum* also occur in New Zealand in the Auckland Province in much the same kind of habitat, though on higher ground rather than in the hollows. During the greater part of the year ground of this nature is continuously wet, and holds much water, but in the summer months it is liable to be dried up. The view taken in this paper is that the large development of the protocorm in *L. laterale* is an adaptation to carry the young plant over the dry season. This would seem to be indicated in the continued lateral development of protophylls with swollen bases, and by the distinction so frequently to be observed between the original protocorm and the protocormous rhizome. The fact that the protocorm of *L. cernuum* also occasionally extends laterally as a rhizome indicates that the Lycopod protocorm is a plastic organ, and that too much stress must not be laid from a phylogenetic point of view upon the fact of its normally large development in *L. laterale*. The writer desires rather to emphasize the fact that a well-developed protocorm, which in its first stage is of the same nature as that so well known in *L. cernuum*, has been found also in *L. laterale*; that it is there correlated with a prothallus of the *cernuum* type; and that *L. laterale* belongs to the same subgenus *Rhopalostachya* as do the other members of the *Lycopodiaceae* (with the possible exception of *L. phlegmaria*) in which a protocorm has been recorded.

CONCLUSIONS.

1. In *L. laterale* and occasionally also in *L. cernuum* (though there to a less extent) the protocorm is capable of considerable development, and constitutes the plant-body proper for a lengthy period. The vascular strand of the stem and first root takes a course through its tissues. The rhizome of *L. laterale* may even branch and give rise to more than one stem-axis.

2. There is a marked developmental distinction in *L. laterale* between the original protocorm and its rhizomatous extension. This suggests that the two portions must be interpreted apart from one another.

3. In *L. laterale* the manner of development of the protocormous rhizome suggests that its large size is an adaptation to carry the young plant over the dry season which normally always follows the wet winter season.

4. In *L. laterale* the protocorm is associated with the *cernuum* type of prothallus, and this is the case also in the other *Lycopodiaceae* in which a protocorm has been recorded. This type of prothallus has been stated on other grounds to be primitive for the genus. The fact that these protocormous species belong to two groups in the subgenus *Rhopalostachya* suggests a certain degree of antiquity for the protocorm within the genus *Lycopodium*; and, assuming the primitive nature of the *cernuum* type of prothallus, would also suggest that the subgenus *Rhopalostachya* comprises the more primitive members of the *Lycopodiaceae*, and that the genus as a whole should be read as a reduction series rather than as a series which has progressed from those forms which show the simpler type of sporophyte.

ART. X.—*The Ferns and Fern Allies of Mangonui County, with some Notes on Abnormal Forms.*

By H. CARSE.

[*Read before the Auckland Institute, 16th December, 1914.*]

IN the New Zealand botanical area, which embraces, in addition to the mainland, the outlying groups of the Kermadec Islands, the Chatham Islands, and the islands lying to the south,* there are 138 species of ferns, contained in thirty-one genera. In addition, there are twenty-seven varieties named. But there are also a good many forms not included in these species and varieties, in some cases, no doubt, intermediate forms, in others forms not specially distinguished, some of which, in my opinion, are, from their constancy, worthy of distinction.

Of the 138 species, there are in the Mangonui County ninety, and of the varieties acknowledged in Cheeseman's "Manual of the New Zealand Flora" there are fourteen.

The names used in this paper are those of the Manual, except in a few cases where changes have been made in accordance with the rules established by the Botanical Congress of Vienna.†

FILICES.

HYMENOPHYLLACEAE.

1. **Hymenophyllum** Linn.

Twenty species in Manual, represented by eleven species in Mangonui County.

2. **Trichomanes** Smith.

Seven species in Manual, represented by five species.

In shaded gullies *Hymenophyllum scabrum* A. Rich. grows luxuriously, especially on trees leaning over the creek. Here, too, are found *H. dilatatum*, *H. demissum*, *H. polyanthos*, and others, though by no means confined to this situation.

My most recent discovery among these delicate ferns in this district was *H. Cheesemanii*. For years I have searched for this tiny fern without success, always looking for it "among moss on the upper branches of forest-trees." When I did find it, however, it was on the stems of small trees, hidden in a dense growth of moss, which Mr. Cheeseman informs me is a very unusual position. I have even found it on the shady side of a kauri-tree, and, last of all, I did find it on the upper branches of a fallen tree.

H. ferrugineum Colla. occurs plentifully in damp gullies on the stems of *Dicksonia squarrosa*, not infrequently mixed with *Trichomanes venosum* R. Br. *T. reniforme* Forst., the "kidney fern," occurs plentifully on fallen logs as a rule.

The most interesting among these ferns in this district is *T. strictum* Menz. It is decidedly rare. Usually it occurs in damp forests, but near Kaitaia, the only place where this fern has been noted in the county, it is growing on deeply shaded clay banks of a creek, and also on the margins

* "Manual of the New Zealand Flora," Cheeseman, preface, p. iv.

† 'Notes on Botanical Nomenclature," Cheeseman, Trans. N.Z. Inst., vol. 40, p. 464, 1908.

of "potholes" from which gum has been dug on the moorlands. "A very remarkable locality, as the species is almost invariably a denizen of the deep forest."*

CYATHEACEAE.

3. **Loxsoma** R. Br.

One species, not uncommon in district.

4. **Cyathea** Smith.

Four species, of which two occur.

5. **Hemitelia** R. Br.

One species, which occurs plentifully.

7. **Dicksonia** L'Herit.

Three species, two of which are common.

Loxsoma Cunninghamii R. Br., a unique species, occurs freely in this county in some parts, though it is absent from large areas.

According to Professor Goebel, of Munich, to whom specimens were sent, "*Loxsoma* is closely related to *Cyatheaceae*, and has nothing to do with the filmy ferns *Gleichenia* and *Polypodiaceae*." For a full description of the prothallus, showing its resemblance to that of cyatheaceous ferns, reference should be made to "Archegoniatenstudien: xiv, *Loxsoma* und das System der Farne," by Dr. Goebel, in "Abdruck aus Flora oder Allgemeine Botanische Zeitung," heft i, published by Gustav Fischer, Jena.

Cyathea dealbata Swartz and *C. medullaris* Swartz are both plentiful, and it is quite possible that *C. Cunninghamii* Hook. f. also occurs, though I have not yet come on it.

Hemitelia Smithii Hook. is plentiful in damp forests.

Dicksonia squarrosa Swartz is a characteristic of low-lying forest, in many places covering considerable areas, almost to the exclusion of other vegetation. *D. lanata* Col. always affects a drier habitat, occurring freely on slopes in the forest. In the north it usually develops a caudex, prostrate and rooting for some distance, then rising to a height of 3–6 ft.

POLYPODIACEAE.

This suborder includes seventeen out of the thirty-one genera.

8. **Davallia** Smith.

Three species, of which one only occurs here, *D. novae-zealandiae*, and is apparently very rare.

10. **Lindsaya** Dryander.

Three species, two of which (*L. cuneata* C. Chr. and *L. linearis* Swartz) are not uncommon.

L. linearis is distinctly a moorland plant, occurring freely on clay slopes. The sterile fronds are always much shorter and broader than the fertile ones, and frequently grow in a rosulate manner.

L. cuneata belongs to the forests, usually growing on the upper slopes. This is a very variable fern. One form has the frond distinctly tripinnate with the ultimate segments deeply pinnatfid, another is bipinnate, and a third is simply pinnate. This last is var. *Lessonii* Hook. f. Not infrequently the two latter forms are found on the one plant.

* Cheeseman, Trans. N.Z. Inst., vol. 43, p. 185, 1911.

11. Adiantum Linn.

Of the six species of maidenhairs, *Adiantum formosum* alone is absent.

A. aethiopicum Linn., the most delicately cut and graceful of the species we have in New Zealand, is not uncommon in lowland situations, occurring freely in places on ditch-banks and on margins of wet patches.

A. diaphanum Blume is also usually to be found in damp places, both in lowland forests and among damp rocks in the higher forests. Sometimes it is simply pinnate, or it may have 1–2 or rarely 3 branches in addition to the main pinna.

A. hispidulum Swartz is usually found on a rather dry slope or bank of a dry ditch, often associated with *Doodia media*. In its young state the frond has a delicate appearance, and is often bright red in colour; in maturity the frond is harsh and rigid in appearance, and dark green in colour.

A. affine Willd.: this, or the larger form at least, is one of our handsomest ferns. The best-developed specimens are to be looked for in lowland country, among shaded woods. In the larger forms the frond is divided into two or three pairs of pinnae with a long terminal one, the lower pairs usually being branched, so that the frond is really tripinnate or occasionally 4-pinnate. Smaller forms, often not more than 1 2 in. high, at times simply pinnate, are found on dry rocks.

A form with narrower and more acute pinnules occurs, in which the secondary rachides are more or less pubescent. This is probably a connecting-link with the next species.

A. fulvum Raoul occurs plentifully in drier parts of the forest. It is much more branched than *A. affine*, the fronds frequently being 4-pinnate.

12. Hypolepis Bernh.

Two of the three species (*H. tenuifolia* Bernh. and *H. distans* Hook.) occur, and, while they are distributed throughout the district, neither is at all common.

H. tenuifolia is rather a puzzling plant, owing not only to the varied forms it assumes in different habitats, but also to its close resemblance to *Polypodium punctatum*—a resemblance so close, indeed, that doubts have been expressed as to whether the two ferns are not merely varying forms of the one species.

Technically, the distinctions are as follows:—

Hypolepis.—Sorus placed on the sinuses between the teeth or lobes. Indusium composed of the reflexed scale-like tip of a lobule of the frond.

Polypodium.—Sorus close to the margin of the lobes, but not absolutely on the margin. Indusium entirely absent. Rhachis and stipes distinctly viscid-pubescent.

When the characteristics above alluded to are well marked there is no difficulty at all in distinguishing the two ferns; but, except in the young state, it is often difficult to detect the pseudo-involucre of *Hypolepis*. Sometimes, however, it is but feebly developed, and occasionally it is slightly developed in what, from the viscidity of the rhachis, is decidedly a *Polypodium*.

I have noted three chief forms of *Hypolepis tenuifolia*. In shaded lowland woods, often on the bank of a small creek, and always in moist soil, occurs the largest and handsomest form of all. The stipes is 1–4 ft. high, the frond 2–4 ft. long, and broad in proportion. This I take to be *Cheilanthes pellucida* Col.

Another and smaller form occurs in the forest, usually on decaying masses of Asteliads which have fallen from the upper branches of trees. As this is also a favourite habitat of *Polypodium punctatum*, a careful examination is necessary to make sure as to which fern it is.

A third and very distinct form, though undoubtedly connected by intermediates, occurs in open damp land, often on the edge of a swamp, in full sunshine. This form is less robust as a rule, almost glabrous, and paler in colour, but usually the reflexed tip of the lobule is clearly marked.

H. distans Hook. is nowhere common, though scattered through the forest district, often, like *Polypodium punctatum*, growing on decaying vegetable matter. In damp shady parts of the forest it often attains much greater dimensions than are given in the Manual, which says, "Stipes, 3–9 in. long; fronds, 6–15 in. long, 3–6 in. broad." Here it is not uncommon to find it with stipes 9–12 in.; frond, 24–36 in. long, 9–12 in. broad.

It is not uncommon for this handsome slender fern, when growing in great luxuriance, to assume the habit of a climber, twining itself for support round more robust plants among which it grows.

13. Cheilanthes Swartz.

Two species, one of which (*C. Sieberi* Kunze) is found here and there on dry rocks.

14. Pellaea Link.

There are two species of this fern in New Zealand, both of which are found in Mangonui County.

P. falcata Fée. has so far only been noticed in the vicinity of Kaitaia, where Mr. H. B. Matthews discovered it.

P. rotundifolia Hook. is plentiful, not in dry woods, as stated in the Manual, but chiefly in damp low-lying woods subject to inundation.

15. Pteris Linn.

The whole of the six species mentioned in the Manual occur in the district.

P. aquilina Linn. var *esculenta* Hook. f. covers vast areas where forests have been cleared and grasses have been sown insufficiently or have died out. This fern springs up in countless thousands on neglected burns. Probably before this country was settled by white people the area occupied by this now almost ubiquitous pest was very much more restricted.

"Fern-root," the starchy rhizome of this plant, was at one time an important part of the vegetable food of the Maori, but it is to be noted that it was not all or any of the plants that were used. Certain places became noted for "*roi*," the edible rhizome. Probably some difference or peculiarity of soil or situation rendered one particular patch more suitable than others, though I have failed to detect any structural differences in plants from these chosen spots.

It is also worthy of note that pigs enclosed on a patch of fern persistently neglect certain plants, though their rhizomes appear quite as succulent and as well developed as those they greedily devour.

P. scaberula A. Rich. occurs plentifully in dry open woods, but more particularly on exposed places, such as roadside cuttings and old landslips, where it forms a dense covering, almost to the exclusion of other vegetation.

The curious scrambling, almost liane-like form occasionally assumed by *P. aquilina* when growing in the shade has been referred to by Dr. Cockayne.*

P. tremula R. Br. attains its greatest luxuriance when growing in damp, shaded, lowland woods. When well grown it stands 5 6 ft. high before the fronds droop gracefully outward.

P. macilenta A. Rich., like the above, grows most luxuriantly in damp lowland woods; but it occurs also in the forests, not only in shaded gullies, but on the drier slopes, and even among comparatively dry rocks. It is the most variable species of the genus. Two forms only are described in the Manual, the type and var. *pendula* (Col.) Cheesem., but there is another common and distinct form, usually occurring among rocks in the higher parts of the forest. It is much more slender than the type, with the primary pinnae fewer and more distant, 2–4 in. long; secondary pinnae 1–1½ in. long; pinnules ¼–½ in. less deeply incised. It often occurs associated with the typical form, and has certainly a very distinct appearance, though doubtless there are intermediate forms connecting it with the type.

Some years ago I gathered in the bush on my farm a very unusual form which approaches very closely to *P. comans*. Referring to this in a letter, Mr. Cheeseman writes, "*P. macilenta* in its ordinary or typical form is very distinct from *P. comans;* but Colenso's *P. pendula* is about half-way between, and what you send is still nearer."

P. comans Forst. is by no means common, occurring, as a rule, on the coast.

P. incisa Thunb.: This beautiful fern is common throughout. It thrives best in damp, lowland woods.

16. Lomaria Willd.

Fourteen species in New Zealand botanical area, of which nine species occur in this district.

Ferns of this family are noticeable from the fact that the fertile fronds differ considerably from the sterile. As a rule, the pinnae of the fertile fronds are narrow-linear, and frequently the entire under-surface is concealed by the sori. Many species develop a more or less erect caudex.

L. discolor Willd. is plentiful in forests, preferring the shady, moist parts. The fronds, rising obliquely from the outer edge of the upper part of the caudex, give the plant a striking resemblance to a crown.

L. lanceolata Spreng. is essentially a fern of the shade, forming graceful festoons on the banks of forest creeks.

L. Banksii Hook. f. is found only on the coast, where it thrives on dripping rocks. I know of only two stations in this district where it occurs, both on the west coast.

L. capensis Willd. is abundant in all situations. This fern is so variable in form and size that at first it is difficult to believe that the small forms found in swamps or on dry clay banks, with fronds often only a few inches long, can belong to the same species as the huge specimens growing on moist cliffs in shaded ravines, or on creek-banks in dark forest gullies, with fronds 8–10 ft. long.

* "Some Noteworthy New Zealand Ferns." L. Cockayne, "The Plant World," vol. 15, No. 3, p. 58, 1912.

In the Manual four varieties of this fern are given. The first three appear to me to show very trivial differences, but var. *minor* Hook. f. is so different that I have no hesitation in classing it as a distinct species, approaching, as Mr. Cheeseman has pointed out, much nearer to *L. vulcanica* Blume.

L. filiformis A. Cunn. is abundant in forests, draping the trunks of trees with its dark-green pendulous fronds. This fern is "remarkable for its long climbing rhizome and dimorphic sterile fronds." They might almost be called trimorphic, for in the juvenile form on the ground the sterile fronds are often only an inch or two in length, with pinnae ⅛–¼ in. long. Higher up they are 4–6 in. long, with pinnae ¼–¾ in., and still higher are fronds 1–2½ ft. in length, with pinnae 1½–4 in. long.

The fertile fronds have quite a feathery appearance, due to the slenderness of the pinnae and to the fact that they are usually gracefully curved, and curled at the ends.

L. nigra Col. is not uncommon in deep ravines in the more hilly parts of the district. In the Manual, Whangarei is given as the northern limit of this fern, but since its publication the occurrence of *L. nigra* is the far north has been recorded.*

L. fluviatilis Spreng. is plentiful in places, but local. It is most frequent, as its name implies, on the banks of streams in the forest, though it is by no means confined to such spots. The gracefully drooping crown of fronds makes this fern a welcome addition to the fernery.

L. membranacea Col. occurs frequently on creek-banks, damp forest slopes, and in lowland woods. In its juvenile form it is remarkable for the enlarged terminal part of the frond, closely resembling in shape small specimens of *L. nigra*.

Large specimens of this fern are sometimes rather difficult to distinguish from *L. lanceolata*, but, as a rule, in *L. membranacea* the pinnae are shorter and more obtuse, not decurrent at the base as in *L. lanceolata*, and distinctly separate one from another.

L. Fraseri A. Cunn.: Abundant in forests throughout. This fern is distinguished from all others of the family by its being the only one with bipinnate fronds. The long slender caudex gives this handsome fern the appearance of a miniature tree-fern. The caudex is occasionally over 3 ft. in length, and fronds much larger than the dimensions usually given in books occur. In the Manual the measurements given are: "Pinnae 2–3 in. long, pinnules ¼–⅓ in. long." In specimens gathered in the forest here the dimensions are: Pinnae 4–6 in. long, pinnules ½–¾ in. long.

17. Doodia R. Br.

The two species both occur in the district.

D. media R. Br. is usually found in fairly open country, frequently associated with *Adiantum hispidulum*, and, like it, often red in colour in the young state.

D. caudata R. Br. can, as a rule, be at once distinguished from *D. media* by the marked difference of the sterile and fertile fronds; but forms occur which are difficult to place, and I think there is no doubt that the species pass into one another, if, indeed, they are not extreme forms of one species.

* Cheeseman, Trans. N.Z. Inst., vol. 43, p. 185, 1911.

18. Asplenium Linn.

Twelve species in New Zealand, of which nine occur in the Mangonui district. Various states of this beautiful family form a very characteristic feature of the New Zealand forest.

A. adiantoides C. Chr., perhaps better known as *A. falcatum* Lam., is one of the handsomest ferns we have. It may often be seen pendent from masses of *Astelia* in forest-trees; usually the pendulous forms are more elongated. I gathered a specimen near here which greatly exceeds the dimensions given in the Manual. The measurements there given are: Stipes, 6–12 in. long; fronds, 1–3 ft. long; pinnae, 12–25 pairs. The measurements of my specimen are: Stipes, 22 in.; frond, 5 ft. 4 in.; pinnae, 47 pairs. The total length of this specimen is 7 ft. 2 in.

A. obtusatum Forst. occurs sparingly on maritime rocks. This fern reminds me closely of the northern *A. marinum*.

A. lucidum Forst. is undoubtedly one of the most variable ferns we have. In addition to the type form, there are four varieties mentioned in the Manual, but there are many forms intermediate among them, and even forms connecting with other species.

The type form is plentiful in damp, shaded parts of the forest, and can usually be distinguished by its long acuminate pointed pinnae.

Var. *obliquum* Moore is a smaller, more coriaceous plant, much blunter in the pinnae, often, in exposed situations, hardly distinguishable from *A. obtusatum*, of which it is probably a connecting-link with *A. lucidum*.

Var. *Lyallii* Hook. f.: Rare in this district. One of the forms occurring here bears considerable resemblance to *A. bulbiferum*, even to bearing the bulbils.

A. Hookerianum Col. is apparently rare and local, a small variety having been gathered in the vicinity of Kaitaia.

A. bulbiferum Forst. is quite a characteristic fern of the shaded bush, attaining its greatest luxuriance in deep gullies. The typical form is very distinct, but there are many variable forms, some of which are rather puzzling.

Var. *tripinnatum* Hook. f. is a clearly marked form, but I am not at all clear as to var. *laxum* Hook f. In the Manual it is described as being without bulbils. I have a form, not uncommon in places, which agrees fairly well with the description of var. *laxum*, except that it as often as not produces bulbils. There is another, and not uncommon, form which, so far as I have seen, never produces bulbils at all. The frond is 12–18 in. long without the stipes, simply pinnate, or barely bipinnate in the lower part of the frond. Usually the pinnae are deeply toothed or lobed, especially on the upper part. It usually occurs on damp clay banks. This form is very distinct, and is, in my opinion, as worthy of varietal rank as any of the others. Possibly it is a transitional form approaching *A. flaccidum*.

A. flaccidum Forst. varies more in form, I think, than any other fern we have. No doubt the variations are due to a great extent to the nature of the habitat, but even among the epiphytic plants, and among plants growing on the same tree, there are remarkable differences in the shape, size, and angle of the lobes.

Among the terrestrial forms the differences are much greater. Rupestral forms are not unlike the pendent epiphytes except in size and rigidity, but forms growing in shady forests differ widely. One not un-

common form is bulbiferous, and closely resembles some forms of *A. bulbiferum;* another is very like a slender form of *A. lucidum.*

A. umbrosum J. Sm. is plentiful in moist shaded places. Its stout fleshy rhizome enables it to linger for years on alluvial flats after the forest has been cleared; so persistent is it, in fact, that it becomes a weed. The fronds are rather delicate, and blacken at the first frost.

A. japonicum Thunb.: This fern is plentiful in alluvial soil in the immediate neighbourhood of Kaiaka, and occurs here and there along the river-bank in the Kaitaia district.

It is by no means a common plant in New Zealand. It was, I believe, first noted in the Dominion on the Okura Creek (Bay of Islands); later I reported it from Kaitaia; and since then it has been found on the Northern Wairoa River. It grows best in low-lying alluvial woods.

19. Aspidium Swartz.

Seven species are listed in the Manual, two only of which grow in this district.

A. Richardii Hook. is usually found among rocks, maritime and inland. It varies considerably as to the extent to which the pinnae are divided, and the shape and toothing of the pinnules. As might be expected, forms growing on exposed rocks, maritime or inland, are more coriaceous in texture, and have shorter and blunter pinnules, than those whose habitat is more favourable.

A. adiantiforme (Forst.) J. Sm. is, in my opinion, one of the most handsome ferns we have. It occurs most freely on mounds of humus in the forest, often climbing for some distance up the trunks of trees. Small plants often grow on the stems of tree-ferns.

20. Nephrodium Rich.

Eight species, all of which, except the Kermadec Island *N. setigerum* Bak., occur in the county.

N. Thelypteris Desv. var. *squamulosum* Schlect. is found in several swampy places from the North Cape to Reef Point, rarely far from the sea.

This is one of the seven species of ferns which are common to Europe and the Southern Hemisphere. The others are *Hymenophyllum Tunbridgense, H. unilaterale, Aspidium aculeatum, Gymnogramme leptophylla, Ophioglossum vulgatum,* and *Botrychium lunaria.*

The var. *squamulosum* appears to be confined to New Zealand and South Africa.

N. decompositum R. Br. is not uncommon in damp woods in rich alluvial soil.

N. glabellum A. Cunn. occurs freely in damp shady forests. "Botanists are indebted to Mr. Kirk for clearing up the confusion which had arisen regarding this and the preceding species."*

The main differences are that *N. decompositum* has a creeping rhizome, the fronds being scattered along it, while *N. glabellum* has a short tufted rhizome, with the fronds much narrower at the base and darker in colour.

N. velutinum Hook. f. is usually found in hilly forest, generally in rocky ground. The dense velvety pubescence distinguishes it from allied plants.

* "The Ferns and Fern Allies of New Zealand," G. M. Thomson, p. 82.

N. hispidum Hook. is a most characteristic fern of damp shaded gullies in the forest. It is one of the largest species in the family, and is easily distinguished by the rigid bristles on the stipes and rhachis.

N. gongylodes Schott, probably better known as *N. unitum* R. Br., is essentially a tropical fern, and was for a long time supposed to occur "only in the immediate neighbourhood of the hot springs and lakes of the North Island."*

This fern is however, by no means uncommon in marshes, mostly maritime, from the North Cape to Reef Point.

N. parasiticum, Desv. = *N. molle* Desv.: Like *N. unitum*, this is a tropical fern. According to Thomson (*l.c.*, p. 84), "It is only known certainly from one locality in New Zealand—viz., on the bank of the Otumakokori or Boiling River, at the foot of the Paeroa Range, in the North Island, and there it occurs sparingly." Since then it was found on "margins of hot springs at Wairakei" (Taupo) (Manual. p. 1006). But more recent discoveries have shown that this lovely fern is not quite as restricted as was thought. Some years ago my friend Mr. H. B. Matthews, of Kaitaia, discovered a small patch of *N. parasiticum* on the slopes of Pukewhau, not far from Rangaunu Harbour, a wide opening on the north-east coast of the county. Last year he and I were delighted to find several fair-sized clumps and scattered plants on the bank of the Kaitaia-Awanui River, a few miles below Kaitaia. The situation is sheltered on all sides by tall scrub, and, judging from the size of the largest patch, the plant has been long established.

Mr. Matthews is of opinion that this fern was at one time fairly plentiful along the river, but the advent of cattle has caused it to decrease. He also thinks that the patch at Mangatete (Pukewhau) may have originated from spores carried by cattle, which in the early days were pastured sometimes on the river-bank, and at others in the hilly country around Mangatete, about ten miles distant. This is quite feasible, for a portion of a frond bearing ripe spores might have travelled from the one station to the other in the cleft of a bullock's hoof, or even if a beast had browsed off a part of a frond before leaving one place some of the spores so carried to the other might have developed in the new habitat; but, be this as it may, this rare fern occurs in both places.

Nephrodium parasiticum is a fern well worth a place in every fernery, but it requires a sheltered situation, thriving well in a glasshouse. Its pale-green delicate fronds, with slender acuminate pinnae, ascending and drooping gracefully, render the plant a ching of beauty.

Judging by the dimensions given in the Manual, our northern form is quite as well developed as the forms which occur in the heated soil and warm vapours of the Hot Lake district.

It is quite possible that this fern may yet be found in other parts of the county, or even south from here. "It has been recorded from Whangarei by Mr. Robert Mair."† This, however, has not been confirmed.

22. Polypodium Linn.

"This, the largest genus of ferns, containing over 500 species, found in all parts of the world" (Manual, p. 1008), is represented in New Zealand by ten species, all of which, save *P. novae-zealandiae*, occur in this district.

* "The Fern and Fern Allies of New Zealand," G. M. Thomson, p. 84.
† Thomson, *l.c.*, p. 84.

P. punctatum Thunb. is, as noted under *Hypolepis tenuifolia*, so near to that species as to be very difficult of distinction, especially when dry. The technical differences between the two species are the recurved lobule forming a pseudo-involucre in *H. tenuifolia*, absent in *P. punctatum*, and the position of the sori—on the margins of the sinuses in *Hypolepis*, and farther from the margins in *Polypodium*. But in practice these are not altogether trustworthy. In some forms of *Hypolepis* the spurious involucre is hardly or not at all developed, and sometimes it appears slightly in *Polypodium*, while the sori of the latter are frequently distinctly marginal. When green, however, the viscid-pubescence of the stipes, rachides, and even of the pinnules of *P. punctatum* at once identifies this species.

P. pennigerum Forst. attains its greatest luxuriance in shaded gullies on the banks of streams, where it develops a caudex 1–4 ft. or more in length, giving the plant the appearance of a small tree-fern.

P. australe Mett. is not uncommon. It occurs on rocks and rather dry banks in the forest, but it is more common on the trunks of forest-trees. Var. *villosum* Hook. appears to be more plentiful than the type. It is difficult to get a good specimen, as the fronds are often attacked by some grub or insect.

P. grammitidis R. Br. is abundant on the trunks of small and the upper branches of large trees. Occasionally it is found among moss-covered peaty soil where the original forest is giving place to scrub.

P. tenellum Forst. is undoubtedly one of our loveliest ferns, climbing as it does to a considerable height up the trunks of trees, usually in damp lowland woods, and forming a graceful drape to the dull-brown trunks.

In the mature state this fern is simply pinnate, the pinnae "entire or obscurely undulate-crenate" (Manual, p. 1011); but the juvenile state is quite different—the pinnae are distinctly bipinnate, usually with 3 pairs of stipitate pinnules, and a prolonged lobulate termination.

P. serpens Forst. occurs plentifully, climbing by its long branched rhizome up trees or rocks. Its thick leathery fronds, dimorphous in form, render it a curious rather than an attractive plant.

P. dictyopteris Mett., better known under its old name, *P. Cunninghamii* Hook., is found in most forests in the damper parts, on trunks of trees or on rocks. It usually grows in considerable masses. It is remarkable how retentive of life this fern is. In summer the plants, especially those on rocks, look dry and withered, but a good shower of rain soon fills them up, and they look almost as fresh as ever.

P. pustulatum Forst. occurs plentifully in woods and forests, clothing the trunks of trees to a good height. It is one of the most variable, if not the most variable, of our ferns. In the juvenile form the frond is simple, linear-lanceolate, and in one variety this form is persistent, producing sori, but never attaining the size of the more common form with pinnatifid fronds.

P. Billardieri R. Br. is very plentiful on trees and rocks. This species, too, is exceedingly variable in form and size, according to the conditions of its habitat. Its juvenile form also is simple, and in dry situations this form is persistent. In a damper habitat the frond is deeply pinnatifid, with sometimes as many as 12 segments on each side.

25. Gleichenia Smith.

Of the five species of *Gleichenia* occurring in New Zealand all but *G. dichotoma* Hook., or, as it is now called, *G. linearis* C. B. Clarke, are more or less common.

G. circinata Swartz and *G. dicarpa* R. Br.: There appear to be considerable differences of opinion as to whether the above are really two distinct species, or merely forms of one species. The technical distinctions appear to be mainly in the form of the segments of the pinnae, those of *G. circinata* being flat, while those of *G. dicarpa* are pouch-like; but, as Dr. Cockayne has pointed out,* this pouching of the segments appears to be more or less a matter of sunshine. On a shaded forest slope bordering on marshy land I gathered what I take to be var. *hecistophylla* in which the segments are perfectly flat and the rhachis almost destitute of the woolly scales, which, along with the pouch-like form of the segments, is quite evident in plants a few yards away exposed to the full sunshine. In drying, however, the plants of the shade become to a certain extent pouched. I have been in the habit of using the number of sporangia 1–4 in *G. circinata*, and 1–2, rarely 3, in *G. dicarpa*, but this is rather a frail support to base a distinction on.

G. Cunninghamii Heward occurs plentifully in forests, though it is absent from large areas. It is usually found in fairly high bush. Like the other species, it is proliferous, and a well-grown specimen showing several tiers of umbrella-like fronds has a very striking appearance.

G. flabellata R. Br. is not uncommon, usually in the moorland country, on the sides of streams, or on rather damp slopes.

In the three preceding species the fronds are arranged horizontally in an umbrella-like form; in *G. flabellata*, as indicated by the name, the frond is several times dichotomously divided, and ascends in a fan-like form.

26. **Schizaea** Smith.

The three species recorded in the Manual occur freely in this district.

S. fistulosa Labill. and *S. bifida* Swartz are common plants of the more barren parts of the moorlands. The simple or unbranched form of *S. bifida* is much commoner than the typical plant. It is always much smaller, but is readily distinguished from small forms of *S. fistulosa* by the broader and shorter fertile section. Now and again a bifid frond occurs on one of these plants

S. dichotoma Swartz is not uncommon in kauri forests, but really good specimens are rare. I have two local ones, 14 in. and 18 in. long, but such finds are unusual.

27. **Lygodium** Swartz.

L. articulatum A. Rich. is abundant in forests, often climbing by its slender wiry stems to the tops of tall forest-trees. In its juvenile form it does resemble a fern, though it has an unusual appearance; but when it covers a tall shrub with its graceful fronds, or forms a light-green curtain 50 ft. or more long, hanging from a tall tree, it has a most unfernlike appearance.

28. **Todea** Willd.

Two of the three species recorded occur.

T. barbara Moore and *T. hymenophylloides* A. Rich.: Of these, the former is a true *Todea;* the latter is more frequently classed, as is also *T. superba* Col., with the genus *Leptopteris.*

T. barbara is a denizen of the moorlands of the extreme north of the North Island, extending in its habitat from the North Cape to the neighbourhood of Whangaroa. It is found in considerable quantities, in open

* "Some Noteworthy New Zealand Ferns," Cockayne, p. 55.

gullies as a rule, frequently with its roots in quite wet land and its fronds exposed to sun and wind. The best-known patch of *T. barbara* occurs near Mangonui, and its surroundings are markedly different from the usual spots occupied by it. At Mangonui this plant occurs associated with *Leptospermum* scrub, in dry barren-looking clay soil, the remains of an ancient landslide. In most other places where I have seen it it is closely associated with water. Near Cape Maria van Diemen it is found in an open gully, forming great tussocks in the middle of a morass which at the time I saw it, though after some months of severe drought, was thoroughly saturated. Near Kaitaia it occurs freely in sandy soil on the bank of a small moorland creek, the soil about the roots being quite wet all the year. Even at Mangonui, dry though its surroundings are, the more robust plants invariably occur in hollows, and no doubt the densely massed trunks, shaded by the close-growing fronds, will be able to absorb a considerable amount of moisture.

Dr. Cockayne's remarks on *Todea* and *Leptopteris** are well worth a perusal.

T. hymenophylloides A. Rich. is a handsome fern, characteristic of the deep bush, where it occurs freely in damp gullies, in which it is protected from sun and wind. In well-matured forms the rhizome is produced into a caudex 2–4 ft. in height, from which rises a crown of graceful fronds.

29. **Marattia** Smith.

The one New Zealand species (*M. fraxinea* Smith) occurs sparingly in gullies of the Maungataniwha Range. At one time it was much more plentiful, but the axe of the settler and roving cattle are rapidly rendering this handsome species a thing of the past. The stipes of this fern is articulated at the base into a part of the tuberous rhizome mass, something like a horse's hoof in shape. In the olden days these parts of the plant, which contain the "bud" of succeeding plants, were set in the ground by the Natives as potatoes are now, and, when matured, the starchy rhizomes were cooked and eaten.

30. **Ophioglossum** Linn.

Both the species mentioned in the Manual occur.

O. lusitanicum Linn.: "This, so far as New Zealand is concerned, consists of the varieties *gramineum*, *lusitanicum*, and *minimum* of the Flora and the Handbook" (Manual, p. 1027). The only form of this I have noticed occurs in sandy places near the sea; it is a small slender form, rarely exceeding 4 in. in height, often under 1 in.

O. vulgatum Linn. is not uncommon in damp grassy places and lowland scrub. It can usually be distinguished from *O. lusitanicum* by its larger size, the position of the lamina of the sterile frond, near the middle of the petiole, and the longer fertile spike, with a greater number of sporangia.

31. **Botrychium** Swartz.

One of the species included in the Manual occurs sparingly in the district —*B. ternatum* Swartz. It was at one time not uncommon, but the spread of settlement has changed the face of the country, and this, with many other interesting plants, is becoming rarer year by year.

* Cockayne, *l.c.*, pp. 50–51.

Lycopodiaceae.

1. **Phylloglossum** Kunze.

"A genus of a single species, found in New Zealand, Tasmania, Victoria, and West Australia" (Manual, p. 1033).

P. Drummondii Kunze: This curious little plant is not uncommon on barren clay hills, though frequently absent from large areas. It varies considerably in size and in the number of leaves, my specimens having 3–10 leaves.

2. **Lycopodium** Linn.

Eleven species occur in New Zealand, of which six only are found in this district.

L. Billardieri Spring. is a handsome dark-green Lycopod usually pendent from the branches or trunks of trees or from rocks, but it also occurs freely as a terrestrial plant among *Leptospermum* scrub.

L. densum Labill. occurs freely on clay hills. To the beginner it is rather a puzzling plant, owing to the variation in form of the juvenile and mature plants, and in mature plants to the striking differences between the sterile and fertile branches. In the fertile branches the leaves are more or less densely imbricating and closely appressed, while those of the young plants are much longer and more open in their setting. This species and the following one bear a striking resemblance to miniature pine-trees, the similarity being borne out by the cone-like spikes at the tips of the branchlets.

L. cernuum Linn. is abundant in open clay lands, usually among scrub. It not infrequently occurs on roadside cuttings and old landslides. It is undoubtedly one of the most handsome plants of its class.

L. laterale R. Br. is very plentiful wherever moist peaty soil occurs in the open. The short lateral spikes distinguish this species from its congeners.

L. Drummondii Spring.: This curious little Lycopod was first discovered by Mr. Colenso in 1839, in some locality between Ahipara and Cape Maria van Diemen (Manual, p. 1038). After that no botanist saw it again in the Dominion for about sixty-seven years, when it was rediscovered by my friend Mr. H. B. Matthews, of Kaitaia. It has only been noticed within a limited area in the wet peaty morass at the north end of Lake Tangonge, near Kaitaia. It is proposed to run a big drain through this morass, and, when this is done, I greatly fear that this interesting plant will cease to exist. It may, however, occur in similar country farther north.

L. volubile Forst., the "waewaekoukou" of the Maori, is probably the most widely spread species we have, and the most beautiful. It is frequently used in decorations, for which its long slender branched stems and spreading leaves, forming graceful festoons, make it very suitable.

3. **Tmesipteris** Bernh.

T. tannensis Bernh. is plentiful in forests, where it occurs most commonly on the stems of tree-ferns. Occasionally it is found on rocks or in masses of decayed vegetable matter.

4. **Psilotum** Swartz.

P. triquetrum Swartz is very rare in this district. It was collected by the late Mr. R. H. Matthews on maritime rocks in Rangaunu Harbour and at Merita Bay, the only habitats reported north of Rangitoto Island, near Auckland. It appears to be confined to the coast and to the Hot Springs region of the North Island.

ABNORMAL FORMS AMONG FERNS.

Probably among no other class of plants are abnormal habits of growth so common and so varied as among ferns. Many of these forms are so persistent as to have become recognized as distinct varieties, or even distinct species. In many cases a clear series of gradual changes can be traced from one extreme form to another; in others the strange forms produced are clearly "sports," eccentricities caused by environment, an unusual luxuriance manifested in extraordinary development of some feature of the plant or a depauperation due to the xerophytic conditions under which the plant has grown. In some cases these strange forms become permanent, thus establishing a variety; in others the plants being removed to more favourable habitats become normal. Some of these forms may arise from cross-fertilization in the prothallial stage.

That such intermediate forms do exist is clear to all who have studied the various states of *Doodia media* and *D. caudata*, of *Asplenium bulbiferum* and *A. Hookerianum*, or of *Todea hymenophylloides* and *T. superba*, forms of which it is almost impossible to describe as belonging to either of the plants in the pair under consideration.

For some years I have noted and collected abnormal growths among ferns, and I propose to set down some of my observations, not so much to increase the knowledge on this point, but rather to elicit further information on a point of no little interest.

Hymenophyllum.

Irregularities in this family are apparently rare; bifurcation of the frond is all I have noticed, and that only in *H. demissum*, the commonest of them all.

Cyathea.

C. medullaris and *C. dealbata*, especially in the juvenile form, frequently have the ends of one or more of the primary ferns bifurcated.

Hemitelia.

I have noticed a similar bifurcation in young fronds of this species, but all who are interested in this subject should refer to vol. 19 of the "Transactions of the New Zealand Institute," where Mr. Buchanan figures and describes a remarkable plant of this species having 16 branches.

Lindsaya.

Of *L. linearis* I have a very curious form, collected by the late Mr. Andrew Thompson, of Aponga, in the Whangarei district. The fertile frond in the lower half is distinctly bipinnate, having adventitious rhachides bearing stipitate pinnae; higher up the pinnae are divided into 2–3 stipitate lobes.

L. cuneata has the upper part of the frond divided into two branches occasionally. The occurrence of bipinnate and simply pinnate fronds on the same plant has already been referred to.

Adiantum.

Among the maidenhairs I have seen but few abnormal forms.

In *A. diaphanum* which is simply pinnate, or with one or two branches at the base of the main pinna, occasionally one of these branches is again

branched, thus having 4 pinnae. Occasionally, too, the pinnae are bifurcated at the top. A curious form of this species collected by the late Mr. Andrew Thompson, at Motatau, has quite a compound frond, resembling a small form of *A. affine*.

A. hispidulum is usually dichotomously forked at the base of the frond, both forks being divided into 3–7 linear secondary divisions. Occasionally one or more of these divisions have small pinnate branches. The most curious form I have seen, and that only twice among hundreds of plants examined, has, instead of simple pinnules on the main branches of the secondary divisions, distinctly pinnate branchlets, giving to the plant quite a different appearance from its usual form.

An unusually luxuriant specimen of *A. fulvum* gathered near Pukekohe is distinctly 5-pinnate. This species is "2–3-pinnate or rarely in large specimens 4-pinnate at the base" (Manual, p. 964).

A form occurs which seems to be intermediate between *A. affine* and *A. fulvum*, having some of the characteristics of each.

Pellaea.

Some time ago I collected a very curious form of *Pellaea*. Some of the fronds are very similar to ordinary forms of *P. rotundifolia*, except that the sori are continuous round the margin; but other fronds from the same plant have pinnae of very unusual shapes, with curious lobes, two at least of them being bifidly cleft. The sori of these are all continuous. This is perhaps an intermediate form, between *P. falcata* and *P. rotundifolia*.

Pteris.

I have not noticed many abnormal forms in this family; still, there are a few.

In *P. aquilina* there is a curious form occasionally seen in barren land. The frond, including the stipes, is 4–12 in. high. The lower pinnae are again pinnate for one-third of their length; the rest of them and the whole of the upper pinnae consist of linear obtuse segments 2–4 in. long, crenately lobed almost to the extremity. A very curious form has the segments of the primary and secondary pinnae curved, once or twice forked, ending abruptly or elongated beyond the others, giving the whole plant a very eccentric appearance.

I have also a form of *P. tremula* showing similar aberrations in the ultimate pinnae only.

Lomaria.

L. discolor: "The fronds are frequently forked at the top, and a beautiful sport is in cultivation in which the pinnae are greatly expanded in the upper two-thirds of their length, and deeply pinnatified" (Manual, p. 977). I have not seen this.

L. lanceolata is occasionally forked at the apex of the frond.

L. capensis is the species which, owing doubtless to its variety of forms, exhibits the greatest number of abnormal forms.

The most common variations from the normal are those showing the upper part of the frond or the tips of the pinnae dichotomously divided.

I have met with one form with the ends of the pinnae curiously toothed, so that at first glance one would think it had been bitten by grubs or beetles, but a closer examination shows that the curious toothed lobes are quite natural.

In another form most of the pinnae are deeply incised or lobed in the lower half, the upper half on each being normal.

A very unusual form shows an abnormal development of secondary pinnae. This is from a fair-sized plant with fronds about 6 ft. long. Several of the pinnae were again pinnate. This, I think, is very unusual.

In several of the *Lomariae*, especially in *L. capensis*, there is a tendency to irregularity in the fertile frond. In some one side of the frond is entirely or almost entirely sterile, the other fertile; or the fertile pinnae may be partly fertile only, the base and extremity being sterile.

In *L. Fraseri*, so far as I have seen, abnormal forms are rare. About a month ago, however, I came across two specimens showing unusual growths. In one the frond is bifurcated at the apex; in the other most of the pinnae for two-thirds of the frond from the base, and usually the apex of the frond, are divided into 2–3 narrow toothed lobes, which are often again divided, giving the fern a crested appearance.

Doodia.

Both *D. media* and *D. caudata* lend themselves to an almost endless variety of forms, some of them so strange and fantastic that one is forced to believe that nature was suffering from nightmare when she designed them.

One very graceful form is a small variety, with stipes only about 1 in. long, frond 4–9 in., with pinnae $\frac{1}{8}$–$\frac{1}{2}$ in. long. In this form the lobes are always much more sharply toothed- spinous, in fact — suggesting an arrested juvenile form.

The most ordinary abnormality is the forking of the elongated upper section of the frond; not uncommonly one of these forks is again forked.

In one specimen this forking is carried to an extraordinary degree, one of the main forks being divided into 3 secondary branches, the other into 2. On the same plant a frond has one of the forks divided into 4 branches, two of which are again branched, but it is too much "mixed up" to show in a drawing.

In a curious state of *D. caudata*, not uncommon in a lowland forest near Kaiataia, most of the fronds are more or less forked at the apex or pinnately divided at the base.

Asplenium.

Many curious forms occur among some of the species of *Asplenium*.

A. lucidum is not infrequently forked at the apex of the frond or at the extremities of the pinnae. A specimen I gathered near Kaitaia nearly thirty years ago has a curious thumb-like projection from the upper sides of the bases of the pinnae in the middle of the frond.

A persistent juvenile form of variety *obliquum* occurs. The fronds are simple, resembling miniature specimens of the hart's tongue of the Northern Hemisphere (*Scolopendrium*); this is probably a depauperated state, but it lasts for years, and produces spores readily.

In a very unusual form almost every pinna is deeply lobed or incised, often almost symmetrically. On the same plant were fronds almost normal, but no frond was without two or three at least more or less lobed pinnae.

From the same locality, near Ahipara, I got numerous specimens in which in place of fairly regular lobes the pinnae are mostly deeply and irregularly notched or lacerated, looking almost as though the cat had been at them, but the clear margins show that this is a natural growth.

Another specimen shows a strangely lobed form; several of the lobes are so folded in since drying as to become hidden.

It has struck me as possible at least that some of these curious forms of *A. lucidum* are states between the type and var. *Lyallii*, but I know too little of the latter to do more than suggest the idea, in the hope that some one else may come forward with an opinion on the point.

A. Hookerianum: Several very puzzling states occur which are difficult to distinguish from *A. bulbiferum.* I think there is no doubt that these two species, in some of their forms, pass into one another, so that it is practically impossible to distinguish the form as belonging to the one or the other.

A. bulbiferum: Though so varied in form, this fern does not seem to produce much in the way of abnormalities, the most common being the forking of the apex of the frond or of some of the pinnae.

Nephrodium.

N. decompositum and *N. glabellum* not uncommonly have the upper part of the frond forked. The ultimate segments of the lower pinnae, too, often show this form.

In several places about here is a crested form of *N. glabellum*, usually smaller than the type, and more finely cut.

Polypodium.

In *P. pennigerum* it is not uncommon to find the upper part of the frond forked. A curious form of this fern was collected in the Aponga (Whangarei) district by the late Mr. Andrew Thompson in January, 1905, and in this district by myself some months later. The peculiarity is that at the base of each pinna, from the middle of the frond, or higher, downwards there are two accessory pinnules, one on the upper and one on the lower side, the upper one being about 2 in. and the lower 1 in. long. Mr. Cheeseman, referring to this, says, "The *Polypodium pennigerum* with the accessory pinnule at the base of the primary pinnae is quite new to me. If it were constant and prevalent in any particular locality it would be worth noticing as a variety."

P. serpens occasionally show a wonderful development of rhizome. In specimens gathered near here the creeping rhizomes are divided into 4–8 main branches; these branches are again and again divided, ending in from 40 to 200 growing points, the conglomerate growth thus formed being 2–4 in. long from the branching to the growing points, and about the same width. I have not noticed this strange growth in any other fern, and am unable to suggest any reason for it.

A very unusual state of *P. dictyopteris* occurs, in which, in place of the ordinary lanceolate or linear-lanceolate form, the frond is more or less broadened, and the margin broken up into numerous elongated lobes, giving the fern a general resemblance to some forms of *P. Billardieri.* It is twenty-six years since I first saw this form, on Mount Maungatapere, near Whangarei, and it was not until last year that I again met with it, in two places in this district.

With regard to *P. pustulatum*, it is difficult to decide which form is typical and which abnormal. I think most of them are abnormal. Still, I suppose we may take as typical the small form 3–9 in. long, quite entire and simple, and the larger pinnatifid form. That being so, the forms with forked fronds must be abnormal, and there seems to be no end to the curious

ways in which they fork—some a simple bifurcation, others, as in a specimen I gathered near Pukekohe, with 3 branches, each branch having 2–4 tertiary branches, some of which are again divided, finally ending in 28 branch-points. In another specimen, not forked, the segments are coarsely toothed, the teeth often being prolonged to linear processes ¼ in. in length.

P. Billardieri occasionally occurs in a handsome crested form. So far I have only found sterile fronds in this state, but the fertile crested form was collected by the late Mr. R. H. Matthews a good many years ago, and recently by Mr. H. Bedggood, near Kaitaia. In ordinary states the sterile frond of *P. Billardieri* has the segments ⅓–1½ in. wide, 1–5 in. long, in opposite or almost opposite pairs, set, at the base at least, almost at right angles with the rhachis, and the texture of the whole frond is very coriaceous. In the crested form the segments are narrower where they emerge from the wing of the rhachis, less regularly opposite, often distinctly alternate, and set at an oblique upward angle. Most of the segments are divided into secondary segments, which are often again and again divided, and the whole frond is very much thinner in texture. So different, in fact, is this form that I am inclined to fancy it a distinct species.

Schizaea.

In *S. fistulosa* the pinnae of the fertile segment are occasionally branched. As I have only noticed one case of this, I conclude that it is of rare occurrence.

Lygodium.

L. articulatum sometimes develops a rather unusual form in the fertile pinnae, in which the pinnules are distinctly leafy, ¼–1 in. long, having the spikelets of sporangia at the extremities of the pinnules or on leafy branches of them.

Marattia.

M. fraxinea is frequently bifurcately or trifurcately divided at the ends of the pinnules. In juvenile forms the pinnae on the same frond may be simple, pinnatifid, or pinnatifid-pinnate—that is, one side of the pinna is pinnate, the pinnules clearly stalked, or parts of both sides may be pinnatifid, the outer part of the pinna bearing stipitate pinnules.

Ophioglossum.

O. lusitanicum not infrequently produces 4 fronds, and very rarely the fertile spike is double, or forked from about the middle.

Botrychium.

B. ternatum, as a rule, has but one fertile segment; rarely, however, in luxuriant forms a second one branching from higher up the petiole of the sterile segment occurs.

Lycopodium.

In *L. Billardieri* occasionally the spikes, instead of branching dichotomously, are conglomerated into a mass of crowded heads with the sporangia compacted together at the very extremity.

L. Drummondii has been gathered near Kaitaia with 2 spikes on a peduncle, but this is very rare.

I trust that others who are interested in the subject of abnormal growths may be induced to publish the results of their investigations.

ART. XI. *The Prothallia of Three New Zealand Lycopods.*

By Miss K. V. EDGERLEY, M.A.

[*Read before the Auckland Institute, 16th December, 1914.*]

IN no group of vascular cyptogams is so much variation shown in the gametophyte as in the genus *Lycopodium*. Up to the present time the species investigated include only tropical and European forms, though *L. cernuum* and *L. Selago*, two widely spread species, occur in New Zealand. The present investigation deals with the following New Zealand species: (1) *L. volubile* Forst., Prodr.: (2) *L. scariosum* Forst., Prodr.: (3) *L. Billardieri* Spring., Monog. Lycop.

BIBLIOGRAPHY.

Up to recent times the prothallia of *Lycopodium* were quite unknown. The process of the germination of the spore in *Lycopodium* was first described by De Bary in 1858. Then Fankhauser, in 1873, described the mature prothallium of *L. annotinum*. Between 1884 and 1890 Treub obtained important results. He described the prothallium of *L. cernuum* from the germination of the spore to the formation of the young sporophyte, and demonstrated the presence of a protocorm in this species. He also described the prothallia of the epiphytic species *L. phlegmaria*, *L. carinatum*, *L. nummularifolium*, and *L. Hippuris*. In 1898-99 the mature prothallia of *L. clavatum*, *L. annotinum*, *L. complanatum*, and *L. Selago* were investigated by H. Bruchmann, and those of *L. clavatum* by Lang. Later, in 1910, Bruchmann added to his results.

All the investigators mentioned above deal with European or tropical species (except *L. Selago* and *L. cernuum*, very widely spread species). The only mention of New Zealand species is in a paper by Mr. J. Holloway, entitled "A Comparative Study of the Anatomy of Six New Zealand Species of *Lycopodium*,"* where he mentions the external features of the prothallia of *L. cernuum*, *L. scariosum*, *L. laterale*, and *L. Billardieri*.

MATERIAL AND METHODS.

Before going further it is advisable to say something of the material and methods employed in this investigation.

Several prothallia of *L. volubile* were found on the side of a bank on which a mature sporophyte and several young sporophytes were growing. Six of these prothallia were found attached to young sporophytes, but further search of the soil around revealed a single prothallium which gave no indication of bearing a sporophyte. Later this material was supplemented by abundant material collected some years ago by Mr. Holloway. The earliest stages of the prothallium, however, were not obtained; even the smallest examined already bore sexual organs.

The prothallia of *L. scariosum* was also gathered by Mr. Holloway, and in this case again all the younger stages were wanting, even the smallest one sectioned showing the foot of a young sporophyte.

In the case of the epiphytic *L. Billardieri*, part of the material was obtained from Professor Thomas, and some fresh material was also gathered by the writer. These prothallia were found growing on trees, in humus

* Trans. N.Z. Inst., vol. 42, p. 356, 1910.

an inch or two in thickness. They are filamentous, and ramify beneath the surface of the humus. Usually the young plants are found in colonies, and, by tracing them down from young to younger still, one can obtain those which are still attached to prothallia.

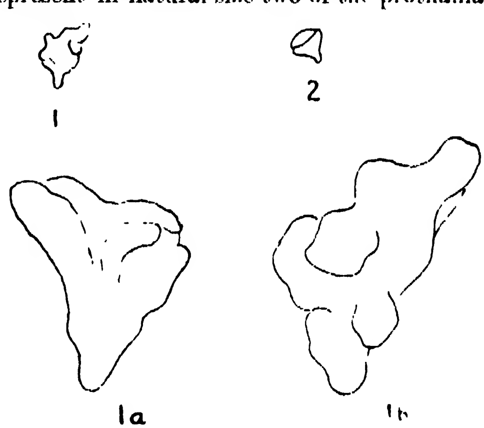
In the case of *L. Billardieri*, and also of *L. Billardieri* var. *novae-zelandicum* Colenso, spores were sown in humus in which the mature sporophytes had been found growing. These spores were sown in April, but up till November showed no signs of germination.

The prothallia gathered by the writer were fixed in chromo-acetic acid, and serial sections cut.

Lycopodium volubile.

External Form.

The size and external form of the prothallium in *L. volubile* can be seen from figs. 1 and 2, which represent in natural size two of the prothallia examined. They are usually subterranean, being buried $\frac{1}{4}$ $\frac{1}{2}$ in. below the surface of the soil. They appear a dirty-white colour, lighter on the upper surface, which is destitute of the long rhizoids which clothe the rest of the prothallium; but the prothallium depicted in fig. 1 contained some chlorophyll in the ridge at the upper right-hand corner, where it had evidently projected above the surface of the soil.



FIGS. 1, 2.—Prothallia of *L. volubile*. Natural size.

FIGS. 1*a*, 1*b*.—Prothallium represented in fig. 1, seen from two different sides.

The prothallia varied somewhat in shape, but in most cases the younger ones examined were more or less conical below, increasing in size higher up. Probably in an earlier stage the prothallium forms a cylindrical body or primary tubercle, which later expands at right angles to its axis, so that in older prothallia the primary tubercle can be distinguished as a small projection from the lower surface of the mature prothallium.

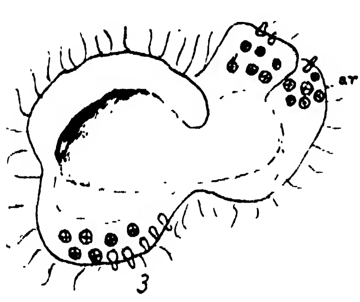


FIG. 3.—Prothallia of *L. volubile*, bearing archegonia. *ar*, archegonia. × 7.

The outer edge of the upper surface is, in most prothallia, surrounded by a ridge, on the inner surface of which the reproductive organs are produced. This ridge does not pass regularly round the whole margin, but is interrupted in places. Thus the upper surface is concave; and possibly this promotes the fertilization of the archegonia, as Lang suggests for the parallel case of *L. clavatum*.

Older prothallia—*e.g.*, that represented in fig. 3—seemed to form a rather flat plate, with a ridge running round the margin of the upper surface. This flattened form was particularly noticeable in some of the prothallia to which young sporophytes were attached.

Internal Structure.

The internal structure of the prothallium of *L. volubile* agrees in its main characters with that of *L. clavatum* or *L. annotinum*. A glance at fig. 4 shows that there is a differentiation into several layers of tissues which correspond in a general way to those of *L. clavatum*. The following tissues can be distinguished:—

(*a*.) On the lower surface a limiting layer of cells, elongated parallel to the surface and destitute of fungus hyphae, except certain cells which form the basal cells of rhizoids. These rhizoids apparently have no fungus hyphae in their cavities, the hyphae penetrating the wall of the basal cell and ramifying in the humus.

(*b*.) Next come several layers of equi-dimensional cells, thin-walled, whose cavities are densely packed with fungus hyphae, which stain deeply with haemalum. Nuclei are present in these cells, but are often somewhat obscured by the fungus. Those cells which border on layer (*a*) are often less densely filled with fungus.

(*c*.) Then follows a rather wide band of nucleated cells, elongated at right angles to the surface of the prothallium. The cell-walls are thick, and many of them contain fungus hyphae, which collect especially where two or more cell-walls meet. The presence of the fungus filaments in the walls renders it rather difficult to see the exact shape of the cells. This layer also has the fungus in the cell-cavities.

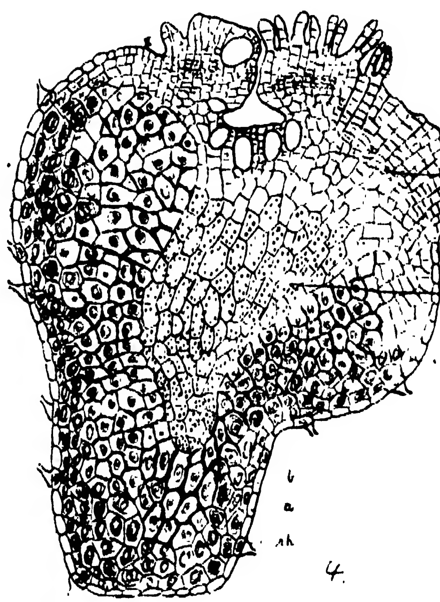


FIG. 4.—Section of young prothallium of *L. volubile*. *a*, limiting layer; *b*, cells with intercellular fungus; *c*, cells with inter- and intra-cellular fungus; *d*, storage tissue; *e*, generative tissue; *rh*, rhizoid. × 82.

The layers marked (*b*) and (*c*) extend not only parallel to the base but also parallel to the sides in the younger radial prothallia. In the older, more flattened, forms only a few rows of cells immediately below the reproductive organs are free from the fungus. From the layer (*c*) starch is absent.

(*d*.) The whole of the central part of the prothallium is occupied by large thin-walled parenchymatous storage-cells, in which starch is stored in great abundance. The cells of this tissue bordering on (*c*) are often smaller and more densely filled with starch granules.

(*e*.) The layer (*d*) passes gradually into a rather delicate layer of small-celled tissue, which passes into more or less radial rows of small-celled

tissue from which the antheridia and archegonia arise on the upper surface of the prothallium.

In comparing the structure of this prothallium with that of *L. clavatum* and of *L. annotinum* one or two striking differences appear. First is the absence of a single layer of cells, elongated at right angles to the surface of the prothallium, lying between the layers marked (*b*) and (*c*), in *L. volubile*, and with the fungus intracellular. This layer of cells is represented by Bruchmann as extremely well marked in *L. annotinum*, and by Lang as quite distinct in *L. clavatum*. Secondly, the occurrence of the fungus in the cell-cavities as well as in the walls of layer (*c*). Thirdly, the absence of starch from layer (*c*) and its abundance in the cells of layer (*d*).

Meristematic Tissue.

The formation of new tissue takes place all round the margin of the prothallium, just beneath the reproductive ridge. The meristematic cells are found on the lower surface of a bay or indentation just below the reproductive ridge (fig. 4, *x*). A section through this region shows a row of cells with large deeply staining nuclei. These cells divide both by periclinal and anticlinal walls. Towards the outer surface of the prothallium, cells formed by anticlinal divisions gradually pass into the elongated cells of the limiting layer; while, within this, meristematic cells pass gradually into the layers which contain the fungus hyphae. More internally, a layer of secondary meristem seems to be differentiated, which gives rise towards the upper surface of the prothallium to radial rows of small cells, and below gradually passes into the large-celled parenchymatous storage region.

Fungus.

Mention has already been made of the fact that certain cells of the prothallium harbour an endophyte. Not only does this fungus not injure the prothallium, but no mature prothallium is found without it. Moreover, the cells in which the fungus is present are quite normal, and a nucleus is always present in them, though it may be almost hidden in the coils of the fungus. It seems quite clear that this is a case of symbiosis, though the exact way in which the endophyte and the prothallium benefit

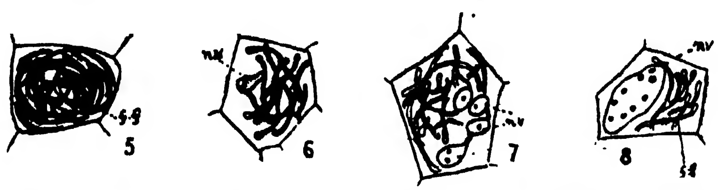


FIG. 5.—Cells of *L. volubile*, containing skein of fungus hyphae. *f.f*, fungal filaments. × 900.

FIGS. 6, 7, 8.—Cells of *L. volubile*, showing the formation of nucleated vesicles (*nv*). × 900.

is not known. Possibly, in the first place the fungus attacked the prothallium of *Lycopodium* parasitically, but the *Lycopodium* prothallium was able to use the fungus to aid its nutrition. In any case, the fungus must obtain some advantage from the association or it would not so generally be found in the prothallial cells. Before the exact relation between the two organisms can be determined it is necessary to know more about the processes of nutrition in the fungus.

In *L. volubile* the hyphae of the fungus pass into the basal cell of the rhizoids, penetrate the outer wall near the base of the rhizoid proper, and so come into contact with the humus in which the prothallium grows.

In order to examine the fungus and trace its distribution, hand-cut sections were soaked in caustic potash, washed in water, and stained with iodine. This treatment caused the fungus filaments to stain a red-brown colour. In different cells the fungus presented quite a different appearance. In many cells, particularly those of layer (*b*) (fig. 4), the hyphae formed a dense coil (fig. 5) or else a number of parallel threads. In others, again, especially in the basal cells of the rhizoids, it formed several thick densely staining threads. In other cells are seen what Lang terms "multinucleate vesicles" (figs. 6, 7, 8). These arise by the swelling-up of the hypha, and at first each contains only one nucleus (fig. 6), which stains deeply, though the vesicles themselves stain lightly. Several of these "multinucleate vesicles" may be present in a single cell. In other cells were dark spore-like bodies, but it was impossible to trace how they arose. Possibly they arose by the bursting of multinucleate vesicles.

Reproductive Organs.

In *L. volubile* the antheridia and archegonia are formed on the same prothallium, and are both confined to the upper surface. Antheridia are usually first formed, the youngest being nearest to the meristematic zone; but as soon as a number have been formed archegonia begin to form nearest the growing-zone. Thus the central part of the upper surface of the prothallium often bears spent antheridia, while the marginal ridge bears mature archegonia. Apparently in some cases a fresh zone of antheridia may be formed, since on one of the prothallia which bore the foot of a young sporophyte all stages of antheridia from the single cell to the spent antheridium were found.

The antheridium arises from a single surface cell which is distinguished by its large nucleus. This cell divides into two, the outer of which forms the cover cells by anticlinal divisions only; while the inner divides repeatedly to form small-celled tissue, the spermatazoid mother cells. From the cells of the prothallium bordering on the mass of spermatazoid mother cells, narrow tabular cells are cut off so that the mature antheridium is surrounded by these cells. At first the cover cells are flush with the surface, but later they project a little in most cases. In one case an antheridium was found which appeared to project beyond the prothallium for fully half its length. Further examination, however, showed that only the six apical cells of the antheridium were cover cells, those lower down which are divided by periclinal walls being prothallial cells.

The archegonia also arise from a single superficial cell which contains a large deeply staining nucleus. This cell divides into a row of three cells, the outer of which forms the neck cells, the inner gives rise to the ovum, and the middle cell to the neck canal cells. The outer divides by a perpendicular wall, and these cells by further divisions form the neck, which in the mature archegonium projects considerably below the surface. A cross-section shows that the neck consists of four rows of cells. The mother cell of the neck canal cells divides. In a nearly mature archegonium only a single division wall had been formed in the neck canal mother cell; but nuclear division had continued so that in the outer cell there were six nuclei arranged in pairs, each pair surrounded by a little cytoplasm. A still later stage shows the ovum below containing a large deeply staining nucleus with a single

nucleolus, and, above, two cells each with a single nucleus; then a cell containing seven nuclei, the lowest four of which are arranged in pairs. The lower part of the archegonium is buried in the tissue of the prothallium, and a layer of tabular cells is cut off round the ovum from the neighbouring prothallial cells.

The Young Sporophyte.

Unfortunately, the writer was not able to trace the different stages in the development of the young sporophyte. The prothallia persist for a long time, and may be found still attached to a young plant which has reached a height of 1½ in. or 2 in. (fig. 9). It is quite common to find two, or even three, sporophytes attached to the same prothallium (figs. 10 and 11). As in all species of *Lycopodium*, the first root appears relatively late, some sporophytes an inch in height showing no trace of it.

Sections of two embryos were obtained which had not yet broken through the prothallium. The youngest was an oval parenchymatous mass, whose cells were very rich in starch (fig. 12). The suspensor consisted of one or two cells, and the stem and foot were quite undifferentiated. The other (fig. 13) was slightly older, and quite spherical, owing to the rapid growth of the cells of the foot segment. The cells of the stem tier were rather smaller, while the outer limiting layer of the foot consisted of large cells.

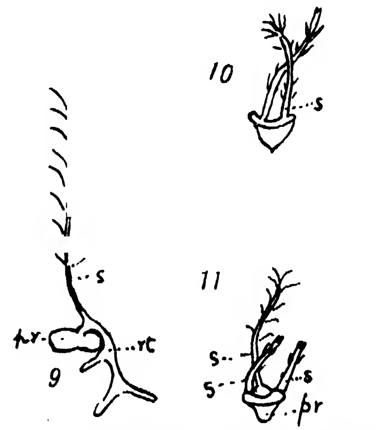
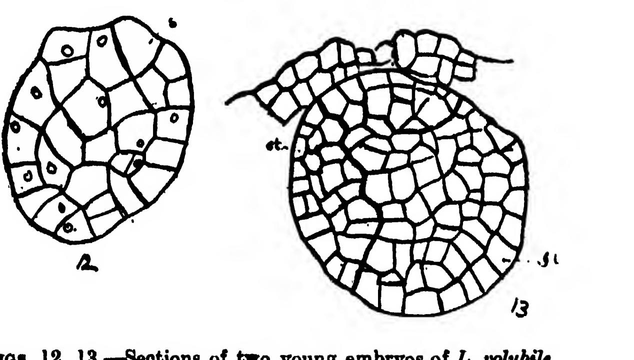


FIG. 9.—Prothallium of *L. volubile*, bearing a single sporophyte. *s*, stem; *pr*, prothallium; *rt*, root. Natural size.
FIGS. 10, 11.—Prothallia of *L. volubile*, bearing two and three young sporophytes respectively. Natural size.



FIGS. 12, 13.—Sections of two young embryos of *L. volubile*. *st*, stem segment; *ft*, foot segment. × 267.

A section of a basal part of a young sporophyte still attached to the prothallium revealed the presence of a massive foot, the outer cells of which form an absorptive layer (fig. 14). The cells of this absorptive layer have much-thickened outer and side walls, which stain very deeply with haemalum.

They have also relatively larger nuclei and more abundant cell-contents. There was no sign of a protocorm. The tissue of the prothallium below the foot consists of rather flattened cells, in which starch is present. Examination of several young sporophytes proved that the vascular bundle does not extend into the foot. It is quite clear that the embryo of *L. volubile* is of the *L. clavatum-annotinum* type.

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FIG. 14.—Foot of same, more highly magnified, showing the limiting layer of cells. × 267.

Lycopodium scariosum.

The prothallia of *L. scariosum* are, according to Mr. Holloway, always subterranean, being deeply buried (4–6 cm.). Like *L. volubile*, the prothallium of *L. scariosum* resembles that of *L. clavatum*, but it is even larger than that of *L. volubile*. The largest specimen cut was 14 mm. by 9 mm. The prothallia were conical below, becoming cylindrical above (figs. 15 and 16). The upper surface of the prothallium is concave, lighter in colour, devoid of rhizoids, and with a ridge running round the margin, on the inner surface of which the sexual organs are found. In other cases—*e.g.*, fig. 17—two ridges have been formed, one towards the centre of the prothallium and the other round the margin. The prothallium mentioned above as the largest was quite different in shape (fig. 15). It was obtuse-angled below, and the whole surface very much lobed and wrinkled.

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FIGS. 15, 16.—Prothallia of *L. scariosum*. × 3.
FIG. 17.—View from above of prothallium. *rd*, reproductive ridge. × 6.

Internal Structure.

The general arrangement of tissues in *L. scariosum* is like that of *L. volubile*, or still more that of *L. clavatum*; but a striking point in which *L. scariosum* differs from both is in the small proportion of its cells

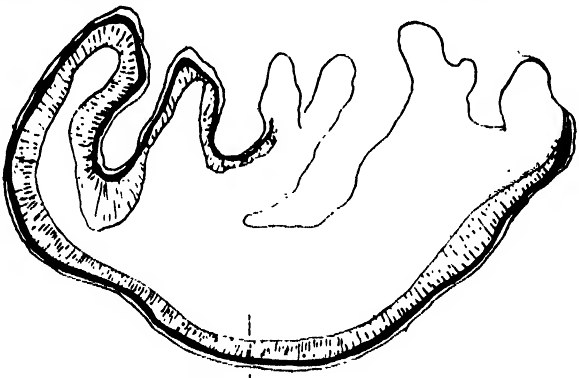


FIG. 18.—Section of prothallium of *L. scariosum*, showing proportion of cells occupied by the fungus.

occupied by the fungus hyphae. A glance at figs. 18 and 19 will show that the tissue infected by the fungus occupies only something like a quarter or a fifth of the whole prothallium, while in *L. volubile* and also in *L. clavatum* it occupies half. Fig. 18 shows that the tissue infected by the fungus extends also, in parts, to the lobes of the upper surface.

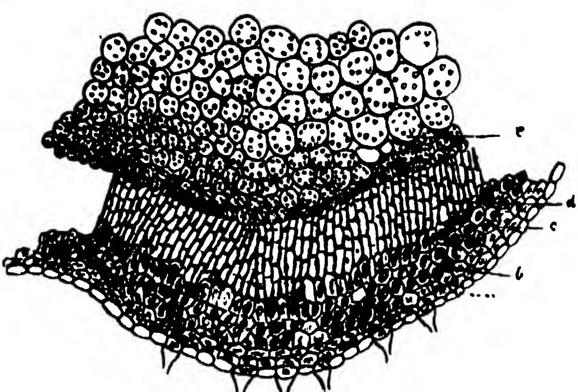


FIG. 19.—Section of lower part of prothallium of *L. scariosum*. *a*, limiting layer; *b*, *c*, and *d*, the layers occupied by the fungus; *e*, storage layer. × 80.

The tissues of the prothallium of *L. scariosum* are,—

(*a*.) A limiting layer of elongated cells, from some of which rhizoids spring. These rhizoids may be merely prolongations of an epidermal cell or may be cut off from a basal cell by a cell-wall. They show the presence of fungus hyphae inside their cavities.

(*b.*) Several layers of cells, the lower two or three elongated parallel to the surface, and containing only a few thickened filaments of the fungus; the upper equi-dimensional, and containing a dense skein of fungus filaments.

(*c.*) Then a single layer of cells elongated at right angles to the surface, with the endophyte intracellular. This is a fairly definite layer, and corresponds to the similar one described by Lang and Bruchmann in *L. clavatum* and by Bruchmann in *L. annotinum.*

(*d.*) Then several layers of cells elongated at right angles to the surface, thick-walled, especially at the angles, and with the fungus in their walls but not in the cell-cavities. In this it differs from *L. volubile*, but agrees with *L. clavatum.* When sections were tested with iodine to demonstrate the presence of starch the cell-walls of this layer showed a faint blue colour, though no starch grains could be detected. The question arises whether starch was present in small quantities in the filaments of the fungus which spread in the cell-walls.

(*e.*) Above (*d*) was the storage layer of parenchymatous cells as in *L. volubile.*

The meristematic tissue and the fungus were exactly as in *L. volubile.*

Reproductive Organs.

The position of the reproductive organs is similar to that of *L. volubile.* Unfortunately, all the prothallia examined were rather old, even the smallest showing the presence of a foot of a young plant when cut.

It was not, therefore, possible to trace the development of the antheridium in detail, but the mature antheridium is quite sunk beneath the surface of the prothallium, and probably opens by a single cap cell. In one antheridium some mature spermatazoids were found, and these were of the usual Lycopodiaceous type.

The earliest stages of archegonia found showed a neck of two cells, while the central row of cells consisted of ovum and three canal cells. In one instance the end cell of the central series showed two nuclei. A later stage shows an ovum and six cells in the central series, in three of which the nuclei are paired. The difficulty of counting the neck canal nuclei is increased by the fact that the cells of the neck contain deeply staining nuclei, which often lie against the wall separating the neck cells from the axial row of cells. In the mature archegonium the cell-walls of the axial row of cells have disappeared, and there remain the ovum and nine nuclei, the six lowest of which are in pairs. The neck cells split apart, and the four rows of cells diverge.

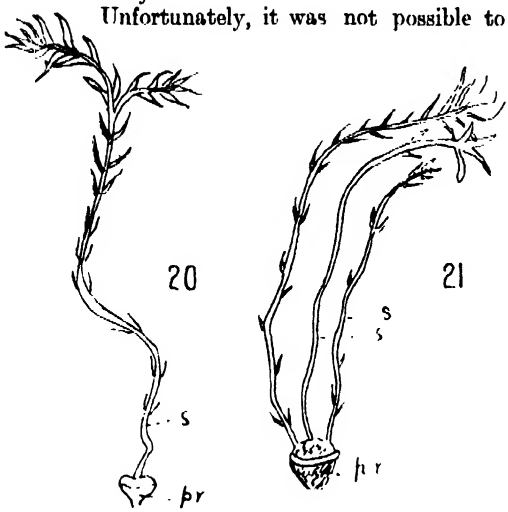
In *Lycopodium* the number of cells in the axial row varies widely. In *L. clavatum* and *L. annotinum* there are 6–10 or more, especially in *L. annotinum; L. phlegmaria* has 3–5, according to Treub; whereas in *L. cernuum* and *L. inundatum* the number may be reduced to one. Further, it is very common for some of the nuclear divisions not to be followed by cell division, so that the nuclei are associated in pairs.

The Young Sporophyte.

The fertilization of one archegonium of a prothallium of *L. scariosum* does not prevent the fertilization of others. There may be only one sporophyte to a prothallium (fig. 20), but it is quite common to find two young sporophytes attached to the same prothallium, and in one case

(fig. 21) three young sporophytes had reached practically the same height. Although they were all about 1½ in. high, the prothallium showed no signs of decay.

Unfortunately, it was not possible to obtain sufficient stages to trace the development of the embryo, but it is probably of the *L. clavatum* type. The foot is large and persistent, a fact which is in relation to the depth of the prothallium below the surface of the soil, and the late appearance of the first root. The foot may be recognized as a small projection at the base of a young sporophyte which has become detached from the prothallium. The first-formed leaves are scale-like.



FIGS. 20, 21.— Prothallia of *L. scariosum*, bearing one and three young sporophytes respectively. Natural size.

A longitudinal section of the base of a young plant still attached to a prothallium passing through the foot shows essentially the same structure as in *L. volubile*. There is a limiting layer of cells with more abundant contents and large nuclei.

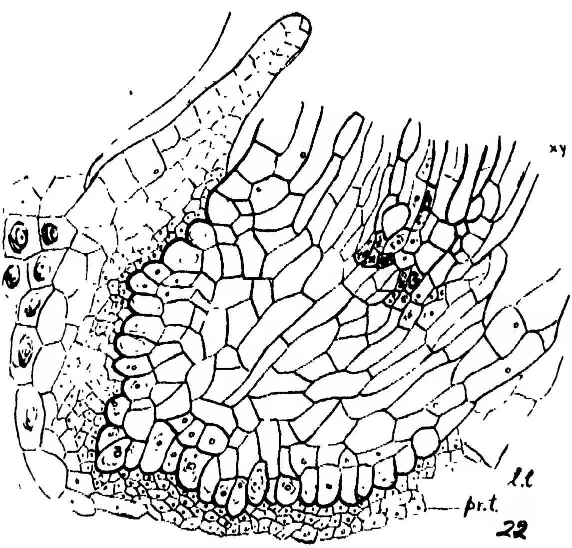


FIG. 22.—Section through foot of young plant of *L. scariosum* still attached to prothallium. *xy*, xylem; *pr.t*, prothallial tissue; *l.l*, limiting layer of foot × 267.

The cells of the foot are large, and though there is no prolongation of the vascular tissue into the foot the central cells are elongated to assist conduction (fig. 22).

Lycopodium Billardieri.

The early stages of development of the prothallium in *L. Billardieri* were not found. The mature prothallium is quite devoid of chlorophyll, and consists of filaments which branch rather sparingly, the formation of vegetative branches taking place in acropetal succession. The prothallium is thickly covered with rhizoids, inclined to the axis of the branch at an angle of 60 or 70 degrees (figs. 23–31). The branches are cylindrical in form, and growth is terminal; but the young branches are usually obovate, being thicker at the distal end. The extreme ends of the branches also appear lighter in colour, owing to the absence of the fungus hyphae from their cells.

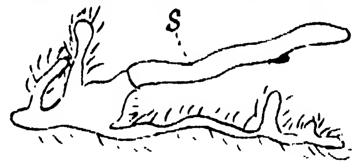


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Fig. 23.—Prothallium of *L. Billardieri*, bearing young sporophyte. × 6.

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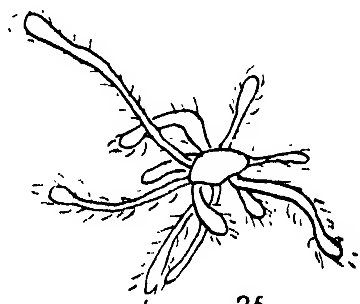

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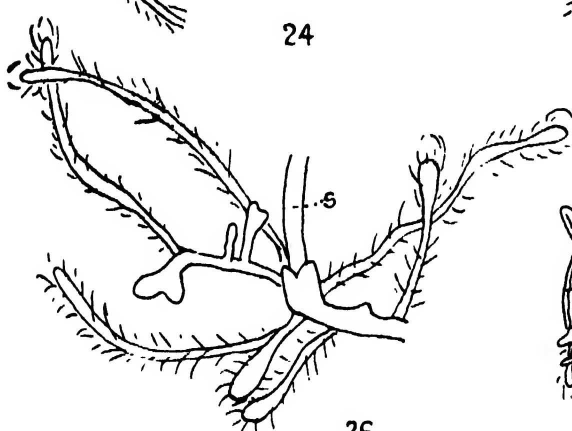

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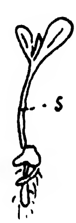

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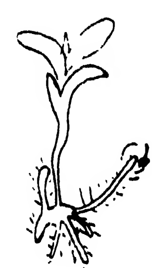

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Fig. 24.—Prothallium of *L. Billardieri*, surrounded by detached branches. × 6.

Fig. 25.—Reproductive branch of *L. Billardieri*, bearing vegetative branches radiating out in all directions. × 6.

Fig. 26.—Prothallium of *L. Billardieri*, bearing young sporophyte.

Figs. 27, 28.—Reproductive branch of *L. Billardieri*, bearing young sporophyte. Natural size.

The vegetative branches may grow to some length, but some become thicker at their growing end and bear antheridia. After the formation of antheridia has continued some time the same branch may form archegonia. As soon as a branch begins to form sexual organs it gives off branches much

more freely, several branches often arising side by side, which never occurs in a vegetative branch. (Figs. 24, 25, and 26.)

The branches may die off behind and form new prothallia. The same would happen if a branch were accidentally detached. In some cases prothallia are found surrounded by numerous detached branches, whose

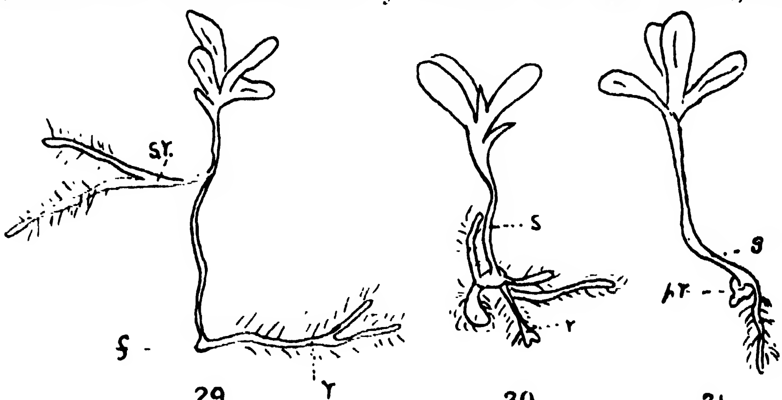


FIG. 29.—Young sporophyte detached from prothallium but still showing foot. × 2.
FIGS. 30, 31.—Prothallia of *L. Billardieri*, bearing young sporophyte with first root developed. *r*, root. × 2.

rhizoids are interlaced with those of the parent prothallium. In this way prothallia are able to increase rapidly when circumstances are favourable, a power which is no doubt of great value, since the initial difficulty in the germination of the spore is so great.

Minute Structure of Vegetative Branches.

A longitudinal section of a vegetative branch shows a certain differentiation of tissues. A mature branch (fig. 32) shows,—

(*a*.) In the centre several rows of elongated cells with scanty contents.

(*b*.) Then two rows of cells, the region infected by the fungus. These cells are equi-dimensional and contain a distinct nucleus. In many of these cells the fungus hyphae form a dense skein, and in others there were several bodies which stain very deeply with haemalum. Further search showed that these dark bodies arose from the fungus, and are probably spores. The fungus was also intercellular.

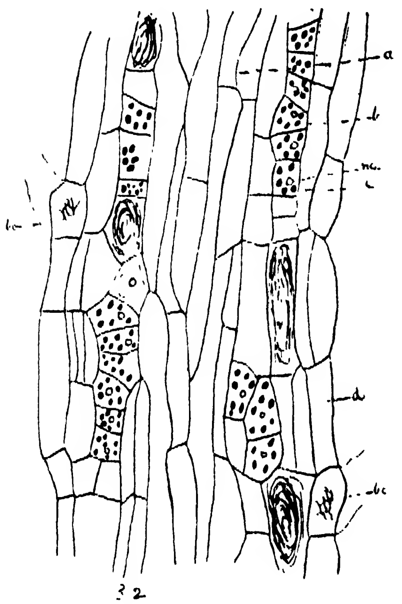
(*c*.) A single row of elongated cells.

(*d*.) The peripheral layer, usually a single row of cells, elongated parallel to the axis of the branch, and covered with a thin cuticle. At intervals are cells rather shorter, which give rise to rhizoids. These cells are the only ones of the peripheral layer to contain fungus filaments. A branch treated with caustic potash and stained with iodine showed the presence of numerous pits on the cell-walls lying between any two of the cells of the peripheral layer. The external wall and the wall opposite to it were not pitted. Careful search failed to reveal similar pits in the transverse walls of the central tissue which Treub describes as present in *L. phlegmaria*.

Growing-point.

A longitudinal section of the growing end of a branch revealed the presence of two initial cells (fig. 33) which are characterized by large

nuclei. Apparently the mode of growth is exactly the same as in *L. phlegmaria.* Both transverse and longitudinal divisions are formed so that the cells at the apex of a branch are equi-dimensional. A short distance behind the apex differentiation of the tissues takes place. Few transverse divisions take place in the central cells, so that elongated cells are formed. Those outside the central cells divide by transverse walls and form equi-dimensional cells, which soon become infected with the fungus. Some of



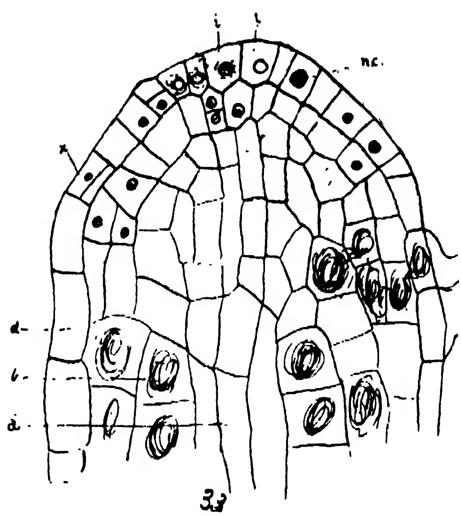


FIG. 32.—Longitudinal section of vegetative branch of *L. Billardieri.* *a*, central cells; *b*, fungus-infected cells; *c*, single row of cells; *d*, peripheral layer; *b.c*, basal cell of rhizoid; *nc*, nucleus. × 267.

FIG. 33.—Longitudinal section of apex of vegetative branch. *a*, central cells; *b*, fungus-infected cells; *c*, single row of cells; *d*, peripheral layer; *nc*, nucleus; *i*, initial cell. × 367.

the cells of the peripheral layer divide by a periclinal wall (fig. 33, *x*), and the outer wall of the external cell forms a thick cuticle. The external cell grows out and forms a rhizoid, which may grow out to a great length. The wall which separates the rhizoid from the basal cell is extremely thickened and cuticularized.

The development of young branches was not followed in detail, but a young stage showed a few projecting cells of the peripheral layer, and below them a few small parenchymatous cells.

Repeated attempts were made to demonstrate the presence of starch in the cells of the branch, but only the slightest traces of it were found.

Sexual Organs.

The sexual branches of *L. Billardieri* are always dorsiventral, the sexual organs being borne on the upper surface. The presence of sexual organs on any part of the thallus can readily be detected by means of the paraphyses which are always present on the reproductive region (fig. 34). The

reproductive branches differ from the ordinary vegetative branches also in being thicker. Antheridia and archegonia are developed on the same branch, but the antheridia are first formed. A branch about to bear antheridia becomes club-shaped, and the antheridia are formed near the apex, though the apical cell is not used up in their formation (fig. 35). Owing to the rapid division of cells, the antheridia come to lie on the upper surface. The formation of antheridia may continue for some time, but eventually archegonia are formed at the apical end. In the antheridial branch the lower vegetative portion is infected with the fungus, only a few cells immediately below the antheridia being free from it. From the cells of the lower surface rhizoids spring, as in the ordinary vegetative branches.

The paraphyses in *L. Billardieri* consist of three cells, each containing a nucleus and rather scanty protoplasm. The basal cell is often smaller than the others, and the apical cell usually becomes narrower at its distal end. Each arises by the division of a surface cell into two, the outer of which divides again. In only one paraphysis was a tendency to branching seen, where a small protuberance had been formed on one side of the lowest cell. In the small number of cells of which the paraphyses are composed, and in their infrequent branching, they differ strikingly from *L. phlegmaria* and *L. Selago*, in both of which branching of paraphyses is common, and the number of cells may reach nine or twelve.

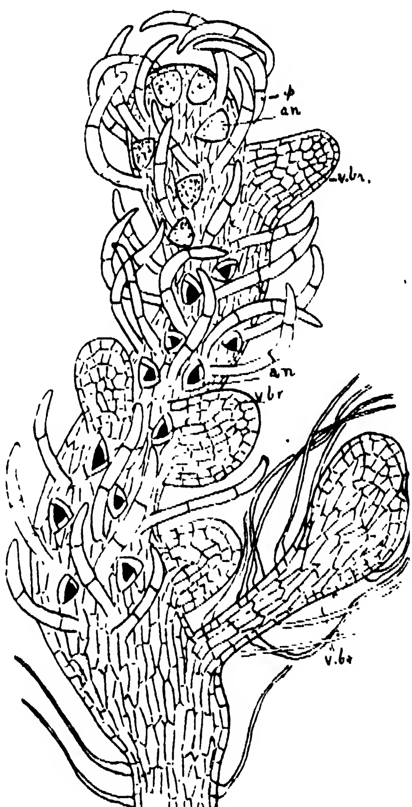


FIG. 34.—Young reproductive branch of *L. Billardieri*, bearing antheridia and young vegetative branches. *v.br*, vegetative branch; *an*, antheridia; *p*, paraphyses. × 82.

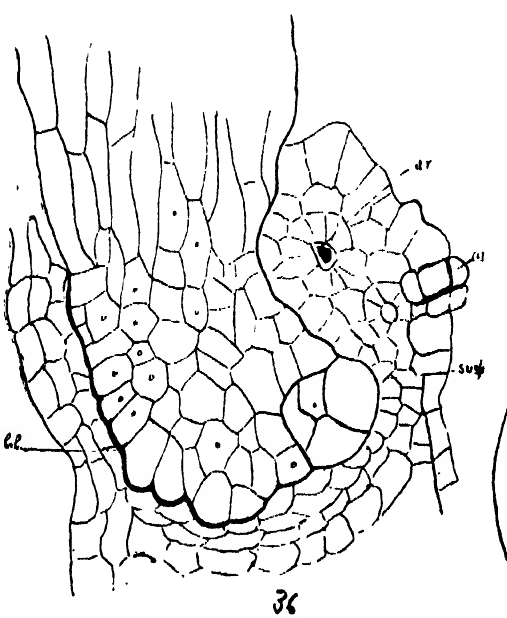
Antheridia arise, as in other species of *Lycopodium*, from single cells which divide into an outer and inner cell; the outer cell gives rise to the cover cell, and the inner to the mass of spermatazoid mother cells.

Development is the same as in other species, and the mature antheridium does not project above the surface. The antheridia may arise so close to one another that they are separated only by a single plate of tabular cells. There is no doubt that in this case the spermatazoids escape by the disintegration of a single cap cell, since when the spermatazoids have escaped the remaining portion of the wall of the cap cell becomes yellow. The development of the spermatazoids was not followed in detail.

Archegonia apparently only develop on branches which have already borne antheridia. As is the case in the formation of antheridia, the meristematic region of the branch is towards the lower surface. The cells of the growing region are distinguished by their large deeply staining nuclei.

FIG. 35.—Longitudinal section of a young antheridial branch, showing initial cell (*i*) pushed to the lower surface; *an*, antheridum; *rh*, rhizoid. × 267.

As in other species, the archegonia can each be traced to a single cell which divides into three, the outer giving rise to the neck, the middle to the neck canal cells, and the innermost to the ovum. The nucleus of the ovum stains deeply, and often shows two deeply staining nucleoli. In the central row of cells only two walls apparently are formed. In a mature archegonium ready for fertilization there appeared a large ovum with a small nucleus close to it, then a large nucleus and three pair of smaller nuclei separated from the ovum by a wall.



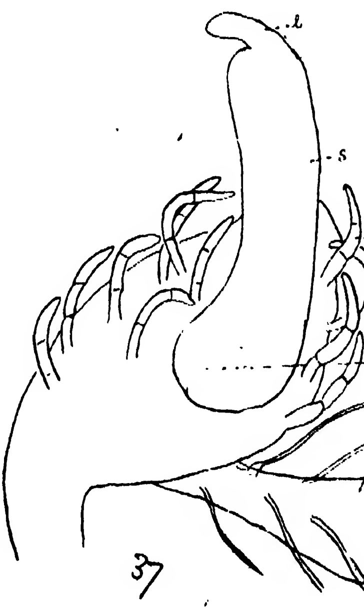


FIG. 36.—Longitudinal section of foot of young plant of *L. Billardieri*, showing suspensor (*susp*). *ar*, remains of archegonium; *l.l*, limiting layer × 267.

FIG. 37.—Prothallium of *L. Billardieri*, bearing young sporophyte, showing only one leaf, *l*. *ft*, foot; *s*, stem; *par*, paraphysis; *veg.br*, vegetative branch. × 82.

The Young Sporophyte.

A glance at figs. 23 to 31 will show that the young sporophyte may remain attached to the prothallium for a long time. Thus sporophytes with four or five leaves and a young root may still be attached to a prothallium. The first-formed leaves are never scaly, since they are produced above the surface of the humus. Even after the young plant has become detached from the prothallium the foot may be distinguished on it (fig. 29). In no case was more than one sporophyte developed on a single branch of the prothallium.

A section through the basal part of a young sporophyte still attached to a prothallium shows a fairly large foot composed of parenchymatous cells, with its outer row of cells characterized by thick walls and more abundant contents. In fig. 36 the suspensor is seen, which consists of only a few cells. No trace of a protocorm was found. Fig. 37 shows a young sporophyte with only a single leaf developed.

Fungus.

Apparently similar to that of *L. volubile*, but no nucleated vesicles were observed. On the other hand, cells with dark spore-like bodies were very common (fig. 32).

SUMMARY.

The results obtained in this investigation may be summarized as follows:—

(1.) The spores of *L. Billardieri* and *L. novae-zelandicum* Colenso, like those of many other species of *Lycopodium*, do not germinate readily. After a period of five months there was no sign of germination.

(2.) The prothallia of *L. volubile* and *L. scariosum* resemble one another externally, but that of *L. scariosum* is larger. Both are usually colourless and saprophytic, but prothallia of *L. volubile* may come above the surface.

The prothallia of *L. Billardieri*, like those of other epiphytic species, closely resemble those of *L. phlegmaria*.

(3.) *Internal Form of Prothallia.*—In a general way, both *L. volubile* and *L. scariosum* resemble *L. clavatum*, but *L. scariosum* differs from both *L. volubile* and *L. clavatum* in the small proportion of its cells in which the fungus is found, the infected tissue being only about a sixth of the whole prothallium in *L. scariosum*, while about a half in *L. volubile* and *L. clavatum*. *L. scariosum* resembles both *L. clavatum* and *L. annotinum* in having a single row of cells elongated at right angles to the surface on the prothallium, and having the fungus intracellular. This layer is absent in *L. volubile*. Again, in the layer of cells marked (*c*) in *L. volubile* and (*d*) in *L. scariosum* the fungus is intercellular only in *L. scariosum*, and both inter- and intra-cellular in *L. volubile*.

The internal structure of *L. Billardieri* closely resembles that of *L. phlegmaria*, but in *L. Billardieri* no pits were seen in the walls of the elongated central cells as described by Treub in *L. phlegmaria*, though the pits in the walls of the peripheral layer were very conspicuous.

(4.) Starch was abundant in both *L. volubile* and *L. scariosum* in the parenchymatous storage layer. In *L. volubile* it was quite absent from the layer below this; but in *L. scariosum* the walls of the cells showed a light-blue colour when treated with iodine, showing possibly that the fungus filaments in the wall contain starch.

(5.) Fungus was present in all three species. In *L. volubile* the fungus does not enter the rhizoids, but pierces the wall of the basal cell of the

rhizoid, and so comes into contact with the humus; while in *L. scariosum* the filaments of the fungus are found also in the cavities of the rhizoids.

(6.) *Reproductive Organs.*—Antheridia in all three species were of the usual Lycopodiaceous type, those in *L. volubile* projecting a little above the surface, while those in *L. scariosum* and *L. Billardieri* were completely sunk in the prothallium.

The development of the archegonia is the same as in other species of *Lycopodium*, the only point of variation being in the neck canal cells, which number four to seven in *L. volubile*, six in *L. scariosum*, and five in *L. Billardieri*.

The paraphyses of *L. Billardieri* are composed of fewer cells than in *L. Selago* and *L. phlegmaria*, and are usually unbranched.

(7.) *Young Sporophyte.*—Though the embryology was not traced in detail, the embryos of *L. volubile* and *L. scariosum* are undoubtedly of the *L. clavatum* type. There is a large persistent foot and no sign of a protocorm. In *L. Billardieri* the foot is fairly large and persistent.

General Remarks.

In the gametophyte of *Lycopodium* there is much greater variation than in any other vascular cyptogams. Thus, H. Bruchmann describes five different types of prothallia—(1) *L. clavatum*, (2) *L. complanatum*, (3) *L. Selago*, (4) *L. inundatum*, and (5) *L. phlegmaria*. After carefully examining these different types he comes to the following conclusion: "It follows from the above facts that the groups of *Lycopodium* characterized especially by means of their sexual generation do not stand in close relation to one another; especially not such as one would expect in species of plants which have found their position together in one genus. The knowledge leads to a separation of the Lycopodiums into groups, or, still better, into genera, to which it would be quite in place to give new names. There arise as many groups as the sexual generation allows to be distinguished." Thus, Bruchmann regards the species of *Lycopodium* as derived from several stocks of Lycopodiaceous plants. This is essentially the same conclusion as that arrived at by Dr. Treub in 1886, when, after remarking on the great difference between the prothallia, embryos, and young plants of *L. cernuum* and *L. phlegmaria*, he proceeds to say, "This is one of the reasons why I believe I may offer the opinion that the profound differences between the prothallia of the Lycopods are of very ancient date, and that they are not the result of very recent adaptations."

But another view of the variations in the prothallia of different species of *Lycopodium* has been given by Lang in 1899, and by Goebel in his "Organography of Plants" in 1905, and it is this view that the facts obtained in the present investigation seem to support. Lang's view is that many of the differences between the different types of *Lycopodium* prothallia are physiologically adaptive in character, and so are not of generic value; and similarly Goebel sees no valid ground for regarding the gap between the several forms of the prothallia of the *Lycopodia* to be so great as Treub and Bruchmann will have it.

With regard to external form, the differences are not so great as they appear, for *L. Selago* may be regarded as intermediate between the radial green prothallia of *L. cernuum* and the filamentous saprophytic *L. phlegmaria*. Again, in regard to internal structure Lang points out that the differences are in the tissues infected by the fungus, and this has been seen also to be the case in *L. volubile* and *L. scariosum*. Thus they are due to

the physiological relation between the fungus and the cells it inhabits and so cannot be used for classification.

In the same way, the differences between the embryo and young plants are closely related to the position of the prothallium, whether at the surface of the soil or some distance below the surface. Again, the appearance of chlorophyll in the tissues is not constant. Thus, in *L. Selago*, when the prothallium grows at the surface of the soil, chlorophyll appears in its subaerial part; and this is also the case in *L. volubile*.

In other characters which are not adaptive the different species of *Lycopodium* agree closely. Thus all species of *Lycopodium* usually show biciliate spermatazoids, archegonia with no basal cell, and a suspensor in the embryo. In all but the epiphytic forms of prothallia growth is essentially intercalary, and in the epiphytic forms the apical growth is in relation to the branched filamentous form.

Thus it appears that in *Lycopodium* the gametophyte and the young stages of the sporophyte are peculiarly adaptive. The experience of botanists proves that the mature sporophyte of plants form a better basis for the interpretation of affinities than does the more plastic embryonal stages, and this is especially the case in *Lycopodium*.

In conclusion, I wish to record my grateful thanks to Professor A. P. W. Thomas for his ever-ready interest in my work, and also to Mr. J. Holloway for permitting me to use material gathered by him.

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Art. XII.—*Some New Species of New Zealand Flowering-plants.*

By L. Cockayne, Ph.D., F.R.S.

[*Read before the Philosophical Institute of Canterbury, 3rd December, 1913.*]

Urtica linearifolia (Hook. f.) Cockayne sp. nov.

This is *U. incisa* Poir. var. *linearifolia* Hook. f. in the "Flora Novae-Zelandiae," i, 225. The differences between *U. incisa* and *U. linearifolia* are succinctly stated by Cheeseman in the "Manual of the New Zealand Flora," p. 636. In addition, it may be pointed out that *U. linearifolia* is a far taller plant than any form of *U. incisa;* indeed, in places it is a semi-liane.

Pittosporum divaricatum Cockayne sp. nov.

Frutex ± 1·5 m. altus, dense divaricato-ramosus, ramis rigidis, saepe valde crassis, intertextis, flexuosis. Folia polymorpha: folia in statu

plantae juvenili, oblonga, obovata, lineari-lanceolata vel lanceolata, ad 16 mm. longa sed saepissime minora, inaequaliter pinnatifida, lobata vel dentata, segmentis magnitudine saepe dissimilibus integerrimis vel lobatis vel dentatis; folia in statu plantae adulto lineari-obovata, oblonga vel ovata, $\pm$ 6 mm. longa, crassa, coriacea, glabra, atro-viridia, integerrima, crenata, dentata vel lobata, obtusa. Flores parvi, solitarii, terminales ad apicem ramulorum perabreviatorum; sepala ovata vel ovato-oblonga, 1·75–2 mm. longa, 3-nervosa, pallide viridia, caduca, leve ciliata; petala lineari-spathulata, apice recurvata, 5 mm. longa, atro-purpurea. fere nigra; ovarium nonnihil hirsutum; capsula subglobosa, circ. 7 mm. diam., rugosa, apice mucronata; semina 2–5.

North Island: Growing in subalpine *Nothofagus* forest, subalpine scrub, and shrub steppe on the volcanic plateau. South Island: Common in montane and subalpine scrubs, and to a lesser degree in subalpine forests throughout the Island, irrespective of rainfall.

P. divaricatum as defined above was, in the "Handbook of the New Zealand Flora," p. 20, included by Hooker along with another quite distinct plant, common on the dividing range of the North Island, in the conception of the aggregate species *P. rigidum.* In their descriptions of this latter both Kirk and Cheeseman have followed Hooker. In 1899 (Trans. N.Z. Inst., vol. 31, p. 363) I called attention to the fact that a specimen of *P. rigidum*, collected by Mr. D. Petrie on Mount Hikurangi, differed, so far as its leaves were concerned, from the common South Island shrub, but closely resembled the figure of *P. rigidum*, pl. x, in vol. i of the "Flora Novae-Zelandiae." I also suggested that probably the common South Island plant was a distinct species. When on the Tararua Mountains in 1906, in company with Professor Easterfield, Mr. B. C. Aston, and some others, plenty of *P. rigidum* of the "Flora Novae-Zelandiae" was encountered, but so different was it in appearance from the South Island shrub that at first I thought we had found something "new." Further study of the two plants led me to give the MS. name of *P. divaricatum* to the common South Island form, but until recently I had not sufficient material on which to base a diagnosis.

I am, then, excluding *P. divaricatum* from the conception of *P. rigidum*, so that this latter species, for those who agree with me, will include only the broad-leaved shrub of the North Island dividing range, the volcanic plateau, and the mountains of western Nelson.

P. rigidum as thus limited differs from *P. divaricatum* in the following important particulars:—

1. The branches are *not* rigid, divaricating, and interlaced, but slender, more or less erect, and branch at a comparatively narrow angle.

2. The leaves are oblong or obovate, and may reach more than 2·5 cm. in length and 1 cm. in breadth.

3. A leaf may be occasionally more or less deeply toothed, but such semi-juvenile leaves are an exception, and never abundantly mixed with the adult, as is not infrequently the case in full-grown shrubs of *P. divaricatum*. Indeed, in a moist forest the actual juvenile form of the latter may be maintained, whereas under identical conditions *P. rigidum* remains purely an adult.

4. Young leaves and young stems of adult *P. rigidum* are densely covered on both surfaces with almost a tomentum of ferruginous hairs, whereas such a covering is quite absent in the young leaves, &c., of *P. divaricatum*.

5. The flowers appear to be axillary, and not on reduced branchlets as in the case of *P. divaricatum*.

Carmichaelia paludosa Cockayne sp. nov.

Frutex erectus, afoliatus, multiramosus, fastigiatus, circ. 1·2 m. altus Ramuli stricti, filiformi, flavido-virides, striati. Racemi vel fasciculi, 2–6-flori floribus minutis breviter pedicellatis. Calyx campanulatus, sparse pilosus, dentibus ciliatis brevissime dentatus. Legumen ellipticum, 9 mm. longum, valide compressum, rostratum rostro stricto 5 mm. longo; semina 2–3, nigro-maculosa.

South Island: Westland—Abundant in lowland swamps. L. C.

Possibly a plant collected many years ago by Mr. D. Petrie in the Clinton Valley, south-west Otago, should be referred to this species.

C. paludosa is evidently closely related to *C. corymbosa* Col., but it appears to differ in its erect, fastigiate, non-drooping habit, somewhat pilose calyx, and larger 2–4-seeded pod. The long straight beak is very characteristic. Colenso describes the beak in *C. corymbosa* as short. By some both species will be included as varieties in the aggregate *C. flagelliformis*.

Gentiana serotina Cockayne sp. nov.

Herba biennis (?) circ. 15 cm. alta. Caulis gracilis, simplex, teres, strictus, purpurascens, 2-striatus. Folia radicalia rosulata, pauca, spathulata, ± 2 cm. longa, apice obtusa; folia caulina in paribus oppositis remotis disposita, sessilia, basi connata, anguste triangularia, ± 1·5 cm. longa, apice acuta, margine integerrima fusco-purpurea. Flores 3–5, circ. 15 mm. diam., in umbellis dispositi vel terminales solitariique; calyx ± 8 mm. longus, lobis 4 subulatis acuminatis ½-⅔-partitus; corolla calycis 2½-plo longiora, alba, alte secta lobis obovatis obtusis sed apice brevissime mucronata.

South Island: Canterbury—Growing in tussock steppe of upper part of the Canterbury Plain and the Malvern Hills. L. C.

This well-marked species perhaps comes nearest to *G. patula*, but is at once separated by its much more slender habit, smaller flowers, narrow acute cauline leaves and acuminate calyx-lobes, which more resemble those of *G. corymbifera* Kirk. Also it only flowers in April or the end of March, whereas *G. patula* blossoms throughout the summer.

Ourisia Crosbyi Cockayne sp. nov.

Herba perennis, gracillima, pubescens, 12–20 cm. alta. Rhizoma longa, 1–1·5 mm. diam., internodiis 1–2 cm. longis. Folia radicalia, pilis brevissimis pubescentia; lamina oblonga vel raro ovata, circ. 3 cm. longa, tenuis, apice obtusa vel subacuta, margine serrata, subtus venis haud reticulatis; petiolus angustissimus, ad 4 cm. longus. Pedunculi gracillimi; bractae paribus oppositis, foliis simules sed minores, sessiles vel breve petiolatae. Flores 3–4, circ. 10 mm. diam.; pedicelli circ. 2–3 mm. longi, gracillimi; calycis-lobi usque ad basin 5-partiti lobis linearis, corollae tubum excedentes; corolla alba, in faucem lutea, tubis brevis; capsula non visi.

South Island: Southland—On floor of subalpine scrub, Longwood Range. Stewart Island—In forest, Mount Anglem. Named in honour of Mr. J. Crosby Smith, F.L.S.

This species is somewhat closely related to *O. Colensoi* Hook. f., but it differs greatly in its very slender habit and its thin, long-petioled, oblong, serrate not crenate leaves, which on the under-surface do not show the reticulating venation so marked in *O. Colensoi*.

Wahlenbergia Matthewsii Cockayne sp. nov.

Herba glabra, perennis, circ. 24 cm. alta. Caules simplices vel pauci ramosi, teretes, obscure striati, purpurascentes, 12–18 cm. longi. Folia

numerosa, conferta, linearia, ± 3·5 cm. longa, 3 mm. lata, pallide viridia aliquanto crassa, coriacea, glabra, sessilia, apice acuta vel subacuta, apicem versus remote dentata. Pedunculi terminales, circ. 10 mm. longi, graciles, erecti, 2–4-ramosi; bractae paucae, breves; calycis-lobi corollam-tubum aequantes, subulati, acuti, circ. 5 mm. longi; corollae-lobi circ. 10 mm. longi, pallide lilacini, ovati, apice acuti; capsula obconica, circ. 6 mm. longa.

South Island: Marlborough—Clarence Valley, near the coast. Named in honour of the late Mr. H. J. Matthews, the discoverer of the plant.

W. Matthewsii is related to *W. vincaeflora* Dcne. (= *W. gracilis* A.D.C.), but is amply distinct in the numerous, close-set, linear leaves, invariable in form, the purplish erect, simple or sparingly branching stems given off closely together from a woody rootstock, and the large pale-lilac flowers.

Celmisia angustifolia Cockayne sp. nov.

Suffrutex *C. discolori* Hook. f. peraffinis sed foliis linearibus differt.

Folia linearia vel angustissime lineari-spathulata, sessilia, numerosa, ± 3 cm. longa, 5 mm. lata, integerrima vel remote brevissime dentata, obtusa vel subacuta, coriacea, supra glabra viscida, subtus dense tomentosa pilis adpressis sericeis albis. Scapus gracilis, viscosus, ± 10 cm. longus; bracteae remotae, lineari-subulatae Capitulum 2–3 cm. diam.; involucri bractae lineares, acutae, glanduloso-pubescentes, viscidae, apice recurvatae; radii ligulae angustae, albae, circ. 1·5 cm. longae, obtusae; achenia sericea.

South Island: Canterbury—In fellfield or steppe from the lower subalpine to the alpine belts on mountains drained by the River Waimakariri, but not where the rainfall is excessive. L. C.

This rather critical species was included by Cheeseman in *C. discolor* Hook. f., an aggregate species containing a most diverse set of plants. This the description clearly shows—*e.g.*, "Leaves very variable in size and shape. 1–2½ in. long, ¼–½ in. wide, oblong-spathulate to linear, obtuse or acute, entire or serrulate, very coriaceous to almost membranous, viscid, glabrous or hoary above"; "broad or narrow at the base, sometimes almost petiolate." (Manual, p. 304.)

A study, however, of the "species" in the field shows that certain forms are constant over considerable areas, and that the prevailing form of one locality is quite absent in others. There are, in fact, various groups of individuals with constant and distinct characters which, in time, will undoubtedly receive distinct names, either specific or varietal; and this does not apply to *C. discolor* merely, but to *C. incana*, *C. longifolia*, and other aggregate species.

C. angustifolia, as here defined, is an exceedingly common plant in the drier mountains drained by the River Waimakariri, where, so far as I know, there are no transitions to the forms of *C. discolor* with oblong-spathulate leaves, so common farther to the south. Such variation as does occur is solely environmental and exhibited for the most part in reduction in size of the aereal organs.

The only doubt I feel in publishing the species is not whether it is well to split up the aggregate *C. discolor* either into species or varieties, but whether *Erigeron novae-zealandiae* Buch. is not the same plant. The resemblance between the two was pointed out to me by Mr. D. Petrie; consequently I have carefully compared Buchanan's drawing and description with my specimens of the Waimakariri plant, and have come to the conclusion that the two are not the same. If, however, plants matching

C. angustifolia are found in the mountains near Collingwood, the habitat of Buchanan's species, the name would be *C. novae-zealandiae* (Buch.), and *C. angustifolia* be a synonym.

B. L. Robinson, of Harvard University, in Proc. Am. Acad., xl, 1913, has changed the name *Celmisia* to *Elcismia* and applied this latter to all the species considered valid in Cheeseman's Manual. The reason for this change, according to Robinson, is that *Celmisia* Cass. in Dict. Sc. Nat., vii, 356 (1817), is distinct from *Celmisia* Cass. in Dict. Sc. Nat., xxxvii, 259 (1825), and that the New Zealand species fall into the latter, while into the former go *Celmisia tabularis*, syn. *Arnica tabularis* Thunb. and *Cel. tomentosa*, syn. *Conyza tomentosa* Burm. f. According to the "Index Kewensis," fasc. i, p. 476, *Celmisia* Cass. (1817) = *Alciope* D.C. (1836), which includes the two species referred by Robinson to *Celmisia*, while *Celmisia* Cass. (1825) is the genus as known in Australasia. The above facts seem to strongly support Robinson's change of name. All the same, it would be a matter for deep regret if a name so universally recognized as *Celmisia* had to be abandoned. It seems to me that New Zealand botanists would do well to wait until the next Botanical Congress, so as to see if *Celmisia* cannot be placed in the list of *nomina conservanda*.

Celmisia Hookeri Cockayne nom. nov.

This is *C. verbascifolia* as defined by Cheeseman in the "Manual of the New Zealand Flora," p. 309, that author being in grave doubt as to whether the material he was dealing with really represented *C. verbascifolia* Hook. f. Nothing needs adding to Cheeseman's admirable description.

C. Hookeri, so far as is known, is confined to north-east Otago, where the climate is comparatively dry. On the other hand, *C. verbascifolia* Hook. f. was based on specimens collected by Lyall near Milford Sound and Preservation Inlet, where the rainfall is excessive. As defined by its author, it is evidently a quite different plant to *C. Hookeri*, being smaller in all its parts and with heads only 5 cm. diameter, as opposed to those of *C. Hookeri*, which are more than 8 cm. diameter.

I think there is little doubt that *C. Brownii* Chapm., a widespread plant in the south-west of Otago, is identical with *C. verbascifolia* Hook. f. Kirk was the first to identify the north-east Otago plant as *C. verbascifolia*, and it is curious that in his "Students' Flora" the original habitat is not cited.

× **Celmisia Christensenii** Cockayne nov. typ. hybrid. (*C. spectabilis* Hook. f. × *C. Traversii* Hook. f.)

Folia vaginam includens ± 16 cm. longa, 3 cm. lata, flexibilia; lamina oblonga, basi subcuneata vel in petiolum brevem sensim attenuata, ± 10 cm. longa, supra viridis irregulariter sulcata glabra nisi nervi medii baso, subtus tomentis pallide fuscis mollibus aliquanto laxis circ. 1 mm. altis vestita, nervo medio breve carinato purpureo sed pilis occulto, margine integerrima pilosa pilis sordide albis sed basin versus fuscis; petiolus brevis, carnosus, circ. 10 mm. latus, tenue canaliculatus, basi in vaginam purpurascentem laxe sericeo-tomentosam 4·5 cm. longam 18 mm. latam dilatatus. Scapus duplo folia excedens, rigidus, crassus, pilis sericeis albis adpressis vestitus; bractae circ. 6, lineares, spathulatae vel vix subulatae, supra virides pilosae pilis sericeis albis sed subtus apiceque pallide fusco-tomentosae. Capitula circ. 4 cm. diam.; involucri bractae lineares, pilis albis pilosae sed apice brunneo-scariosae vel pilis pallido-fuscis vestitae; ligulae 4-nervae, albae, circ. 2·4 cm. longae.

South Island: Fairly common on Mount Charon, near Hanmer. Named in honour of Mr. C. E. Christensen, who is adding so greatly to the knowledge of the botany of Hanmer and its vicinity.

The plant here dealt with is almost certainly a hybrid between *C. spectabilis* Hook. f. and *C. Traversii* Hook. f. It strongly resembles *C. mollis* Cockayne, as may be seen by comparing the above description with that of the latter in Trans. N.Z. Inst., vol. 31, pp. 423–24. But *C. mollis* is undoubtedly a hybrid between *C. spectabilis* Hook. f. and *C. petiolata* Hook. f., the latter a species closely allied to *C. Traversii*.

× *C. Christensenii* is at once distinguished from *C. spectabilis* by the softer slightly rust-coloured tomentum, the purple midrib and petiole, and matted rather dirty-white hairs somewhat rusty-coloured at their bases, which form a fringe round the margin of the leaf.

× **Celmisia Morrisonii** Cockayne nov. typ. hybrid. (*C. coriacea* Hook f. × *C. Traversii* Hook f.)

Folia vaginam includens 21 cm. longa, subflaccida; lamina oblonga, circ. 12 cm. longa, 3·5 cm. lata, subcoriacea, supra pallide viridis sed pilorum tenuissimorum pellicula tenue ex parte occulta, subtus tomentosa pilis sericeis albis adpressis dilute flavido tinctis, inaequaliter sulcata. margine remote dentata mucronibus brevissimis purpureis et indistincte marginata pilis albis sericeis intextis, apice obtusa vel subacuta, nervo medio basi 10 mm. lato carinato et purpureo sed tomento occulto; petiolus carnosus, 2 cm. longus, 1·4 cm. latus, tomentosus, in vaginam 4 cm. longam 2–5 cm. latam lanuginosam lana alba dilatatus. Scapus vix duplo folia excedens, rigidus, crassus, purpureus, pilis albis sericeis adpressis vestitus; bractae numerosae, lineares vel lineari-spathulatae, ad 7·5 mm. longae, ut foliis tomentosae. Capitulum 6 cm. diam.; involucri bractae lineares, ut scapo pilosae, apice scariosae brunneae; ligulae albae, 3 cm. longae. apice obtusae vel 3-dentatae.

South Island: Mount Miromiro, near Hanmer. C. E. Christensen! Named in honour of Mr. W. G. Morrison, who is industriously collecting the high-mountain plants in the neighbourhood of Hanmer.

The more open tomentum, which is not parchment-like, and the flexible leaves with purple midribs, at once separate × *C. Morrisonii* from *C. coriacea* Hook. f., which it resembles in the silvery pellicle of the upper leaf-surface and to a considerable degree in the scape and flower-head. The relationship to *C. Traversii* Hook. f. is more obscure, but it is visible in the purple midrib and petiole, the shape of the leaf and its texture, and in the faint brown tinge of the tomentum.

The purple colour in *C. Traversii* is evidently a distinct unit character. Hybrids between *C. coriacea* and *C. spectabilis* are without a trace of purple.

Regarding the hybrid forms of *Celmisia* on the Hanmer mountains, Mr. Christensen sends me the following interesting particulars: "The peculiar part about the hybrid forms of *Celmisia* at Hanmer is that × *C Christensenii* only grows where *C. Traversii* and *C. spectabilis* grow near one another; while × *C. Morrisonii* only grows where *C. coriacea* and *C. Traversii* are very plentiful—namely, on Mounts Charon and Miromiro. I have not met with it on Mount Captain. There is one gully on Miromiro occupied almost exclusively by × *C. Morrisonii*. Further, *C. Traversii* does not occur on Mount Perceval, so that the hybrids on that mountain must all be between *C. coriacea* and *C. spectabilis*." Specimens of this

latter cross were sent to me by Mr. Christensen, but I await more material before drawing up a diagnosis.

Since writing the above I have been informed that specimens of what is here called × *C. Morrisonii* were some time ago received by Kew from Mr. H. H. Travers, he having in his turn got them from Mr. McEvoy, who had, however, been made acquainted with the plant by Mr. Christensen. Later on, Mr. Travers heard from Kew that the plant would be named *C. insignis*. I am under the impression that this is merely a nomen nudum, and, as I do not know who is the authority for the name, I am not substituting *insignis* for *Morrisonii*, as I would otherwise have done. The hybrid has been known to me since 1899, when I found one plant in the vicinity of Jack's Pass.

Helichrysum (?) dimorphum Cockayne sp. nov.

Frutex scandens circ. 6–8 m. altus. Caulis circ. 2 cm. diam., flexilis, primo non-ramosus denique dense ramosus; ramuli ultimi valde gracillimi, foliis parvis imbricatis adpressis obsiti. Folia in planta juvenili et etiam in planta adulti in umbra crescenta, subpatentes, elliptica vel ovato-oblonga, circ. 3·5–5 mm. longa, 2 mm. lata, brevissime petiolata petiolo 1 mm. lato, coriacea, supra glabra et conspicue nervosa, subtus tomentosa pilis sericeis albidis, margine incrassata glaberrima, apice acuta apiculo brevissimo ornata; folia in planta adulti arcte adpressa, imbricata, squamiformia, lineari-lanceolata, obtusa, 3 mm. longa, 1 mm. lata, supra concava, pilosa pilis albidis sericeis, subtus convexa, glabra. Capitula terminalia, parva, subcylindrica, 9 mm. longa, 3·5 mm. diam. vel minora; involucri squamae multiseriatae, exterioribus oblongis vel obovatis, pilosis, marginibus scariosis apicibus brunneis, interioribus lineari-oblongis, scariosis, obtusis; flosculi circ. 18, omnes hermaphroditi (?); pappi setae numerosae, graciles; achenium glabrum.

South Island: Canterbury—Climbing through and over river-terrace scrub on the banks of the River Poulter, near the Mount White Bridge, and at Puffer's Creek, Waimakariri River basin. L. C.

H. dimorphum is not only one of the rarest species in the flora, only two plants being known so far, but, what is more important, it is a remarkable addition to the lianes of New Zealand.

It can be recognized at a glance by its scrambling habit, slender branchlets with very small, adpressed, scale-like leaves, something after the manner of *Helichrysum microphyllum*, its semi-patent, flat leaves of the reversion-shoots which are glabrous above with the anastomosing raised veins clearly evident, tomentose beneath and with thickened glabrous margins. The heads are very small, long and narrow, and their involucral scales in several series, the outer being much smaller than the inner; the florets are about 18 in number, and are perhaps homogamous; the achene is glabrous. The main stem is stout below, unbranched and flexible. When the tops of the shrubs are gained the plant branches abundantly, forming dense masses of the slender cupressoid twigs.

I am not at all sure as to the genus of the plant, as my material was scanty so far as flower-heads were concerned. However, the main reason for publication is to call attention to this remarkable plant in the hope that some one may be induced to visit the locality where the species is growing and collect more material, or to look for other examples in river-terrace scrub of the Waimakariri or its tributaries.

Cotula Dendyi Cockayne sp. nov.

C. atratae affinis sed robustiora capitulis majoribus, flosculis luteis vel fulvis et involucri bracteis flosculis aequilongis vel excedentibus.

South Island: Common on subalpine and alpine shingle-slips of the drier mountains where there is a steppe climate.

Although this species is extremely close to *C. atrata* Hook. f., it may be at once recognized by the colour of the florets, which are never black, but vary from quite pale yellow to brown, and the involucral bracts equalling or rather longer than the florets. The plant frequently grows in company with *C. atrata.* It is quite possible that the brown-flowered form is a hybrid between the yellow form and the black *C. atrata.*

Senecio southlandicus Cockayne sp. nov.

Herba perennis *S. lagopo* affinis. Folia radicalia suberecta, rosulata: lamina ovato-oblonga, oblonga vel fere rotundata, obtusa, 6-11 cm. longa, membranacea vel subcoriacea, supra aliquando setosa sed plerumque glabra, subtus saepe purpurascens, glabrescentia vel sparse tomentosa pilis sericeis, basi rotundata vel cordata vel truncata: petiolus nonnumquam strictus, 2-12 cm. longus valde glanduloso-pilosus. Scapus 12-30 cm. altus, ramosus, pilosus pilis sericeis adpressis. Capitula saepe 9, 3-4 cm. diam.; involucri bracteae pilosae, apice ferruginosae; radii ligulae 16 mm. longae, patentes, luteae; achenia lineares, glabra.

South Island: Otago—Common in tussock steppe and in the shade of *Leptospermum scoparium* in the neighbourhood of Balclutha, Gore, Tapanui, &c.; but the actual distribution cannot be defined. It has not been noted in North Otago or Canterbury. D. L. Poppelwell! L. C.

The plant here described is, in part, the *S. bellidioides* of Petrie's list of Otago plants.* Also by Kirk and Cheeseman it was similarly placed. But from *S. bellidioides* it differs in its usually much larger size; in the absence of bristles in the greater number of its individual plants, or, if bristles are present, they occur in extremely small numbers; in the purplish undersurface of the leaf, the much-branched scapes, and the numerous heads. From *S. lagopus* Raoul the thin leaves without bristles and the non-glandular scape at once separate it.

The species is, indeed, far more distinct from *S. bellidioides* and *S. lagopus* than are these from one another. The classification of the whole series, including those already mentioned, together with *S. saxifragoides* Hook. f. and *S. Haastii* Hook. f., is in a most unsatisfactory position. Specimens are constantly coming to me from various correspondents which it is impossible to place with any degree of satisfaction. There are undoubtedly a number of well-marked forms, which demand, at the least, varietal names. Even one fixed character may serve quite well as a specific mark. This is illustrated in the case of *S. saxifragoides* and *S. lagopus* (the type from Akaroa), where the presence of numerous bristles, or their absence, on the upper surface of the leaf is the sole distinguishing character, so that, so far as large plants of the two are concerned, if this character were not present, no one could consider them in any degree different.

I must record my thanks to Mr. D. L. Poppelwell, of Gore, who most kindly sent me abundant living material of *S. southlandicus* and extremely valuable ecological notes regarding its sun and shade forms.

* Trans. N.Z. Inst., vol. 28, 1896, p. 564.

ART. XIII.—*An Undescribed Species of* Cotula *from the Chatham Islands.*

By L. COCKAYNE, Ph.D., F.R.S.

Communicated by Dr. Charles Chilton.

[*Read before the Philosophical Institute of Canterbury, 2nd December, 1914.*]

Cotula Renwickii sp. nov.

HERBA perennis, erecta, circ. 1·2 m. alta. Caules stricti, sublignosi, viridi, cicatricibus foliorum annulati. Folia obovato-spathulata, ± 4 cm. longa et ± 14 mm. lata, glabra, membranacea, 5-nervosa, basi aliquanto dilatata, apice 3–5-crenata. Capitula 11 mm. diam., flavida; pedunculi 11 mm. longi, vix pilosi pilis brevissimis albis; involucri bracteae, 2-seriatae, circ. 12, oblongae, 4 mm. longae, glabrae, apicibus scariosis. Radii flores multiseriati; corolla ovoidea, basi dilatata obscure dentata; disci flores numerosi, 4-dentati.

Hab.—Chatham Islands: Growing on the cliffs of the small islets known as the Forty Fours. Named after Mr. Renwick, of Ouwenga, Chatham Islands.

C. Renwickii is evidently closely related to *C. Featherstonii*, but easily recognized by its greater stature, its stems ringed with old leaf-scars, its thin glabrous leaves, those of *C. Featherstonii* being thickly covered with brownish hairs and somewhat succulent, its shorter peduncle and its much larger flower-heads, which, according to Mr. Renwick, are of considerably greater size than as given in the above description.

I only possess one small scrap of the plant,* so the diagnosis will probably need considerable modification and amplification. The specimen was kindly sent to me by my friend, Mr. F. A. D. Cox, who had received it from Mr. Renwick, he in his turn having got it from certain fishermen. These latter, while in the vicinity of the Forty Fours, managed one day to effect a landing—a by no means easy matter—and, while climbing the cliff, some of the plants were broken off. These, falling into the sea, were picked up by those in the boats and taken to Ouwenga, where they came into the possession of Mr. Renwick, who managed for a time to cultivate one plant.

The species is of more than common interest, since, on the one hand, it is so closely related to *C. Featherstonii*, a species hitherto supposed to be quite unlike any other member of the genus, and, on the other hand, it is possibly restricted to the small area where it was discovered, or, at most, it may eventually be found on one or other of the islets of the Chatham Group.

The station, as given above, tells little about the actual habitat. The growth-form is not in the least that of a true rock-plant. The closely related *C. Featherstonii* is supposed to grow only on peat, where mutton-birds nest, and perhaps this new species is restricted to some definite habitat. Mr. Cox is endeavouring to procure more specimens, so that before long something more should be known regarding this interesting species.

* Since writing the above description Mr. D. Petrie has most kindly lent me another specimen, a portion of the same gathering.

Art. XIV.—*Notes on the Plant Covering of the Garvie Mountains, with a List of Species.*

By D. L. Poppelwell.

[*Read before the Otago Institute, 4th August, 1914.*]

General.

The Garvie Mountains are those which lie on the north side of the Mataura River, and stretch from the East Dome in a north-easterly direction for a distance of about twenty-five miles, where they join the Carrick Range. They have a width of about fifteen miles, and drain to the Waikaia River on the south-east, to the Mataura River on the south-west, and to the Nevis Valley on the north-west.

So far as I am aware, nothing has been published concerning the plant covering of this range except some mention of species by Dr. Cockayne from specimens sent him by me. The botany of these mountains is of considerable importance from a phytogeographical point of view, owing to the area mentioned forming the connecting-link between the wet mountains of the west and the drier east of Otago. Furthermore, this area lies as far inland as is possible in Otago, it being practically equidistant from the east, west, and south coasts—namely, between seventy-five and eighty miles.

History of Botanical Investigation.

I first visited the East Dome about five years ago, in March, spending a couple of days there, collecting a number of living plants and taking some notes of the vegetation.

In February, 1910, I spent two days in the vicinity of the Remarkable Gap, reaching the mountain-tops and noting the plant-growth, upon which occasion I also collected a large number of living plants, many of which I sent to Dr. Cockayne, F.R.S., to whom I also supplied notes of the plant associations. During the Christmas holidays of 1910 I again visited these mountains, accompanied by Messrs. G. Biggar and J. Speden, of Gore, and W. A. Thomson and O. Davies, of Dunedin. This visit was from the Nevis Valley, and we went right over Mount Tennyson, down the Nokomai Valley and the Mataura River, to East Dome, where we further investigated the plant formations. In all, about four days were occupied in this way, and the information obtained was communicated to Dr. Cockayne and others.

Lastly, during the Christmas holidays of 1913, in company with Messrs. Biggar, Speden, and Thomson above mentioned, I spent about ten days inspecting the forest in the Upper Waikaia and the mountain flora of the heights in the vicinity, adding considerably to the list of plants previously noted and to my knowledge of the various plant associations, which I now propose to describe. In these investigations I was considerably helped by my companions, all of whom are enthusiastic and skilful collectors, and to whom I am much indebted for assistance given. I would here also like to record my indebtedness to Dr. Cockayne and Mr. D. Petrie for kindly assistance given in identifying doubtful specimens and for useful advice regarding the compilation of these notes.

TOPOGRAPHY.

The Garvie Mountains consist of an elevated range running to a height in places of over 6,000 ft. Most of the range is over 4,000 ft. high, the principal peaks being East Dome (4,350 ft.), The Steeple (4,796 ft.), Mount Tennyson (5,014 ft.), Mount Cameron (5,959 ft.), The Gap (5,925 ft.), and Rocky Mount (6,086 ft.). The rocks are mostly schistose, and on the tops are weathered in many places into strange and grotesque forms. Here and there huge shafts or pillars stand up against the sky-line, while in other places great areas of smooth flat-topped rocks give shelter to an interesting and varied plant-life.

Near the Remarkable Gap some five or six lakes have been formed at a height of over 4,000 ft. The principal lakes are Blue Lake and Gow's Lake. From these natural reservoirs rocky and in some cases almost precipitous torrents dash down to the lower valleys. Most of the ridges are rounded on the tops, and many of them are covered with extensive peat bogs, dotted over with numerous lagoons. These bogs are difficult to travel over, but rich in flora. The ascent of the mountains is for the most part comparatively easy, and a good deal of it could be accomplished on horseback. Many of the tops, however, can only be negotiated by strenuous climbing on foot.

ECOLOGICAL CONDITIONS.

The rounded tops of many of these mountains result in the water-content of the soil at the upper levels being generally greater than might be expected. The average rainfall is not very great, nor do I think the number of rainy days excessive, the area being, in fact, just on the border of the dry district of Central Otago. The elevated nature of the country means that it is frequently snowing here when rain is falling in the lower valleys.* The flattened ridges swept by the westerly gales result in a greater degree of snow-drift than would be found on rougher ground. The heads of the gullies and lee slopes of the ridges where these drifts accumulate become great reservoirs, from which melting snow-water percolates through the soil and keeps it moist. In many places these snow-streams become blocked, and, spreading out, produce large areas of peat bog, the sour, wet soil in parts being too sodden for any but the scantiest vegetation. On the other hand, during the summer months the rocky areas are subject to drying winds and extreme insolation, especially those with a northerly aspect. Strong south-west winds also leave their mark upon the vegetation, the exposed heights being covered with a complete mantle of various cushion plants, particulars of which are noted later.

Numerous deep gorges result in a lessened light, and provide suitable situations for shade-loving species. The lower altitudes, of course, have less snow and more rainfall, the latter soon running off and leaving dry hillsides and a consequently reduced list of species. In the lower gullies beech forest prevails, some of the trees being very tall, especially on the mountain-slopes, where the sun strikes less directly. Both sheep and cattle graze plentifully on these mountains in the summer months, and these have naturally somewhat affected the plant associations, but not yet to such a marked extent as to be very important. Fire, on the other hand, has materially changed the association in some cases, but in others there is a tendency for the burnt spots to reclothe themselves with their lost covering.

* The average annual recorded rainfall at Lumsden for the last seven years is only 33·01 in., and the number of rainy days 172.

THE PLANT ASSOCIATIONS.

In dealing with these it will be necessary to make the distinctions of (1) forest, (2) subalpine scrub, (3) steppe, (4) alpine meadow, (5) rocks and cliffs, (6) bogs and swamps.

(1.) Forest.

The principal forests are those in the head of the Waikaia Valley, in Gow's Creek, and on East Dome. These will be treated separately.

Waikaia Valley Forest.

This is a beech forest, but contains perhaps a larger admixture of other species than is usual in such forests. The beeches noted by me consist of *Nothofagus Menziesii* and *N. Solanderi* at the lower levels, the height above sea-level being about 700 ft. On the higher ground near at hand *Nothofagus fusca* is also growing. The latter species is in places of great height, many trees measuring over 40 metres and some probably over 45 metres tall, the lowest branches being perhaps 20 metres from the base. The trees vary from 1 to 1·5 metres in diameter, and have fine straight boles, although covered in some instances with mosses and lichens. The physiognomy of the forest is sombre, as is usual, although the lighter green colour and more open branches of *N. fusca* at once mark out where it is dominant. On the bank of the Waikaia River in this locality a somewhat mixed association of shrubs was noted, consisting of *Olearia nummularifolia, Carmichaelia robusta, C. subulata, Veronica salicifolia, Olearia aborescens, Senecio elaeagnifolius, Gaultheria erecta, Pittosporum Buchanani, Nothopanax Edgerleyi, N. Colensoi, Fuchsia excorticata, Phylocladus alpinus, Gaya Lyallii, Coprosma crassifolia, Olearia ilicifolia,* and *Podocarpus Hallii*. The creepers *Muehlenbeckia complexa* and *Rubus australis* are also fairly common; while the parasites *Elytranthe Colensoi, E. tetrapetala,* and *E. flavida* are abundant on the beech-trees, and light up the dark forest with blazes of red and orange. Curiously enough, *E. Colensoi* and *E. tetrapetala* were only noted on *Nothofagus Menziesii*, although a close lookout was kept on the other beeches for them.

The plants of the ground layer consist of *Astelia nervosa, Poa Colensoi, Helichrysum bellidioides, Rumex flexuosus, Acaena sanguisorbae, A. pilosa, Senecio bellidioides, Lagenophora petiolata, Hydrocotyle novae-zealandiae, Raoulia glabra, Uncinia riparia, Cardamine heterophylla, Ranunculus lappaceus, Chrysobactron Hookeri, Juncus planifolius, Viola Lyallii, Microlaena avenacea,* and the ferns *Blechnum penna marina, Polystichum vestitum, Asplenium flaccidum, A. Hookerianum, A. flabellifolium,* and *Hymenophyllum multifidum*. Close to the river *Lycopodium Billardieri* was also noted, epiphytic on *Nothofagus Menziesii*. Farther up, as we approach the denser forest, the following make their appearance: *Rubus australis, R. subpauperatus, Carpodetus serratus, Coriaria thymifolia, Coprosma areolata, Corokia cotoneaster, Suttonia divaricata, Coriaria angustissima, Wahlenbergia saxicola,* and *Uncinia rubra*, with *Juncus effusus* and *J. planifolius* in the damp places. In open spots I also noted *Nertera setulosa, Blechnum capense, Helichrysum filicaule, Geranium microphyllum, Pteridium esculentum, Epilobium pubens,* and *Hypolepis tenuifolium*. On the edge of the forest the following are found: *Muehlenbeckia australis, Drimys colorata, Dracophyllum longifolium,* and *Griselinia littoralis*. Here and there under the beech-trees are patches of *Histiopteris incisa, Nertera dichondraefolia,* with the orchids *Pterostylis australis, P. Banksii, Corysanthes*

triloba, and *Chiloglottis cornuta*. A few specimens of *Elaeocarpus Hookerianus* and *Blechnum fluviatile* are also seen. In more or less open spots, where old mine-workings once existed, the association consists of *Ranunculus hirtus, Erectites prenanthoides, Gnaphalium luteo-album, Epilobium alsinoides, E. rotundifolium, Lagenophora petiolata, Celmisia longifolia, Blechnum penna marina, Gaultheria depressa, Geranium microphyllum, Poa Colensoi, Gunnera mixta*, and *Leptospermum scoparium*, with patches of *Raoulia glabra* and the moss *Racromitrium lanuginosum*. Scattered throughout this association the following introduced species were noted: *Holcus lanatus. Prunella vulgaris, Cnicus lanceolatus, Veronica serpylifolia, V. arvensis, Trifolium repens*, and the common *Cryptostemma calendulaceum*. In ponds the following association is common: *Callitriche verna, Cladium Vauthiera*, and *Potamogeton Cheesemanii*.

At a greater altitude *Nothofagus fusca* becomes more plentiful, and a few specimens of *N. cliffortioides* put in appearance. *Podocarpus Hallii* is fairly plentiful, and here and there specimens of *Nothopanax simplex* and *Coprosma foetidissima* are found, especially in the damper places. On the decaying logs and among the humus of the forest floor there is a wealth of the orchids *Caledenia bifolia, Gastrodia Cunninghamii*, and *Adenochilus gracilis*. The following ferns are also found: *Polypodium australe, P. diversifolium, Asplenium bulbiferum, Hymenophyllum multifidum, H. Tunbridgense, Blechnum capense*, and *B. membranacea*. On dry banks *Arthropodium candidum, Lycopodium volubile*, and *L. ramulosum* are sparingly found. Dotted along the tracks patches of *Helichrysum bellidioides, Urtica incisa*, and *Oxalis magellanica* are common. At 1,400 ft. altitude *Pratia angulata* makes its appearance, while the principal floor-covering is *Histiopteris incisa* and *Hypolepis tenuifolia*. *Carpodetus serratus* at this elevation becomes more abundant and of larger dimensions. As we emerged from the forest my notes record *Senecio Lyallii* in full bloom on the bank of a creek, and the stones covered with *Raoulia lutescens*.

Gow's Creek.

The associations of this forest are practically the same as that of the Waikaia forest.

East Dome Forest.

The forest here is not of great dimensions. It commences at an elevation of about 700 ft. above sea-level, and skirts the base of East Dome. The beech-trees are similar to those in Waikaia Valley, but variation in the form and particularly in the size of the leaf is perhaps more marked. On the margin of the forest the following mixed association is found: *Podocarpus totara, P. Hallii, Cordyline australis, Discaria toumatou, Dracophyllum longifolium, Carpodetus serratus, Pittosporum tenuifolium, Griselinia littoralis, Drimys colorata, Corokia cotoneaster, Olearia virgata, Suttonia divaricata, Fuchsia excorticata, Sophora microphylla, Leptospermum scoparium, Coprosma linariifolia, C. crassifolia, Olearia avicenniaefolia, Aristotelia racemosa, A. Colensoi, Podocarpus spicata, Pseudopanax crassifolium, Nothopanax simplex, Gaya Lyallii*, and *Nothopanax Edgerleyi*. The following creepers are fairly common: *Rubus australis, R. subpauperatus, Calystegia tuguriorum* (abundant), *Muehlenbeckia australis, Parsonsia heterophylla, P. capsularis*, and *Clematis indivisa*.

Among the smaller plants along the edge of the forest and in open parts the following are typical: *Hypolepis tenuifolia, Potentilla anserinoides, Asplenium bulbiferum, Polystichum vestitum, Pteridium esculentum, Acaena*

sanguisorbae, *A. novae-zelandiae*, *A. pilosa*, *Juncus effusus*, *Lagenophora petiolata*, *Geranium microphyllum*, *Epilobium* (several species), *Oxalis corniculata*, *Mentha Cunninghamii*, *Acaena microphylla*, *Blechnum capense*, *Geranium sessiliflorum*, *Pratia angulata*, *Coriaria ruscifolia*, *Phormium tenax*, *Blechnum fluviatile*, *Blechnum penna marina*, *Polypodium diversifolium*, *Astelia nervosa*, *Carex lucida*, *Gastrodia Cunninghamii*, *Olearia arborescens*, *Polypodium australe*, *Pteridium esculentum*, *Astelia montana*, *Hydrocotyle novae-zelandiae*, and *Senecio Haastii*. Of parasites I noted *Elytranthe flavida* on *Nothofagus fusca* and *N. Solanderi*, and *Loranthus micranthus*. On a rocky face near the river I also saw *Veronica salicifolia*, *Cyclophorus serpens*, *Helichrysum glomeratum*, *Asplenium flabellifolium*, *Prasophyllum Colensoi*, *Wahlenbergia saxicola*, *Anisotome Haastii*, *Senecio bellidioides*, and *Celmisia petiolata*.

In an address delivered in Gore some years ago I drew attention to the way in which *Leptospermum scoparium* thickets formed a nursery for young *Nothofagus* seedlings, which ultimately destroyed their hosts and took their places. When speaking, I had the East Dome in my mind. Here this succession is also marked, as young *Nothofagus fusca* seedlings are plentiful where the *Leptospermum* is dominant, but where the beech once outgrows its shelter the latter is destroyed by it. This process is plainly evidenced here, where the young beech forest is full of dead *Leptospermum scoparium* of full growth.

Here we have a succession similar to that mentioned by Dr. C. B. Crampton in his " Vegetation of Caithness, considered in Relation to its Geology."* In that paper he states (at page 98), in regard to *Calluna vulgaris* and *Betula alba*, " The heather forms a nursery for the seedling birch, but the latter on maturing into trees exterminate the heather beneath them."

(2.) Subalpine Scrub.

Upper Waikaia Valley.

The subalpine scrub is curiously distributed on the Garvies. In the Upper Waikaia Valley there is hardly any subalpine scrub properly so called, the formation beyond the bush-line being a loose collection of shrubs, fairly open and with none of that characteristic interwoven closeness of high-altitude shrubberies. The dominant plant in this formation appears to be *Phyllocladus alpinus*, which is plentiful and in full bloom in December. *Olearia virgata* is also abundant with *O. nummularifolia*, *Veronica Traversii*, *Olearia Hectori*, *Aristotelia fruticosa*, *Aciphylla squarrosa*, *Dracophyllum longifolium*, *Pentachondra pumila*, *Styphelia Fraseri*, *Anisotome Haastii*, *Scleranthus biflorus*, *Fuchsia Colensoi*, *Senecio elaeagnifolius* (not plentiful), and *Angelica Gingidium*. I also noted one large specimen of *Senecio cassinioides*, in full bloom, its brilliant yellow colour making it conspicuous at a distance of nearly a mile.

On the spur leading to the Titan rocks, at a height of 2,700 ft., there is a large quantity of *Veronica buxifolia* associated with *V. propinqua*, *Cassinia Vauvilliersii*, *Gaultheria depressa*, *Senecio revolutus*, *Gaultheria rupestris*, *Dracophyllum rosmarinifolium*, while the ground plants are *Helichrysum bellidioides*, *Chrysobactron Hookeri*, and *Acaena pilosa*. Apparently a good deal of this ground has been burnt at one time. The *Veronica buxifolia* is only about 6 dcm. high, although in patches where the fire has missed

* Published under the auspices of the Committee for the Survey and Study of British Vegetation.

the plants are from 1 to 1·5 metres high. Farther up on the same spur the association varies between *Veronica-Cassinia* and *Cassinia-Veronica*, those different genera being dominant in turn, the carpet association being much as before mentioned.

Gow's Creek.

The physiognomy of the subalpine scrub near the beech forest here is marked by an uneven surface with great brownish-green patches in parts and a light-grey colour over considerable areas when seen at a distance. Upon closer acquaintance these colours are explained by the presence of *Dacrydium Bidwillii*, the rounded tops and bright colour of which easily give it first place in physiognomic importance. In other parts *Veronica buxifolia* in bloom accounts for the lighter shades. The associations which show the different colours above mentioned might be termed the "*Dacrydium*" and "*Veronica*" associations respectively. They consist of the same species, but the relative abundance of the different dominant species completely accounts for the changed appearance. The general association is as follows: *Veronica buxifolia* (abundant), *V. propinqua*, *Dracophyllum longifolium*, *Cassinia Vauvilliersii*, *Dacrydium Bidwillii* (dominant over considerable areas), *Caladenia bifolia*, *Blechnum penna marina*, *Styphelia Fraseri*, *Gaultheria perplexa*, *Euphrasia zealandica*, *Oreostylidium subulatum*, *Pimelea prostrata*, *Dracophyllum rosmarinifolium*, *Wahlenbergia gracilis*, and *Gaultheria depressa*. Near a creek *Senecio Lyallii* showed in yellow patches, with occasional specimens of *Veronica Traversii* (?).* In places also the following species appeared: *Aristotelia fruticosa*, *Forstera Colensoi*, and *Senecio revolutus*, with occasional specimens of *Danthonia Raoulii* and *Poa Colensoi*, until the scrub gave place to tussock meadow.

East Dome.

The scrub here is much more closely interwoven than in any of the other places examined. It forms a close association on the edge of the beech forest, and is very hard to negotiate. The chief species consist of *Veronica Traversii* (?),* which is plentiful, *Olearia avicenniaefolia*, *O. nummularifolia*, *Coriaria ruscifolia*, *Cassinia Vauvilliersii*, *Dracophyllum longifolium*, *Phormium tenax*, *P. Cookianum*, *Leptospermum scoparium*, *Pittosporum tenuifolium*, *Nothopanax Colensoi*, *Clematis indivisa*, *Veronica buxifolia*, *Astelia montana*, and *Senecio Haastii*. Of these, the *Dracophyllum*, *Pittosporum*, and *Veronica* are dominant.

(3.) STEPPE.

Under this heading I am including those portions of the elevated parts which are covered with tussock meadow. It is impossible to draw a hard-and-fast line between "steppe" and "alpine meadow," although the abundance or not of *Celmisia* makes in these regions a fair test of what constitutes alpine meadow. The land under this head lies between the altitudes of 1,000 ft. and 3,500 ft., although there is necessarily a good deal of overlapping between the different zones, especially as regards *Danthonia Raoulii*, *D. flavescens*, and *D. crassiuscula*.

The plant associations of these steppes beginning at about 1,000 ft. altitude on the east side of the Garvies has *Leptospermum scoparium* as its dominant plant. Frequently this is found as a pure formation where it is closed, but where it is open a mixed association is found. This consists

* Perhaps a form of *V. monticola*.

of *Acaena sanguisorbae*, *A. microphylla* (both plentiful), *Festuca rubra*, *Coriaria thymifolia*, *Poa australis*, *Celmisia longifolia*, *Ranunculus lappaceus*, *Wahlenbergia saxicola*, *Geranium sessiliflorum* var. *glabrum*, *Chrysobactron Hookeri*, *Blechnum penna marina*, *Plantago Browni*, *Acaena pilosa*, *Uncinia rubra*, *Oxalis corniculata*, *Drapetes Dieffenbachii*, *Lagenophora petiolata*, *Gnaphalium Traversii*, *G. paludosum*, and *Styphelia Fraseri*. At 2,200 ft. the first patch of *Veronica buxifolia* is met. The plants are stunted in form, and associated with *Pratia angulata* and *Phormium Cookianum*, the latter, however, being a rare plant in this locality. Here and there patches of *Herpolirion novae-zealandiae* and *Gentiana corymbifera* are also added to the general association.

At about 2,700 ft. a further patch of shrubby plants was also met with, but I have dealt with the association under the heading of subalpine scrub. *Danthonia Raoulii* is plentiful everywhere, and in soft places *Oreobolus pectinatus* cushions are common, with *Colobanthus acicularis*, *Celmisia glandulosa*, and patches of *Raoulia glabra*. In portions of the meadow seedling plants of *Celmisia coriacea* without any adults were noted, but as this ridge forms part of Mr. G. Pinckney's Glenary Run, and is the road leading to the station, no doubt the general association is affected somewhat by the traffic of sheep affecting not only the plants themselves, but also by the carrying of seed in the wool, &c. From a height of about 3,000 ft. the tussock association changes, *Danthonia Raoulii* gradually giving way to *D. crassiuscula*. There is also a tendency for many of the alpine-meadow plants to sparingly put in an appearance. Of these, I noted in "steppe" formations *Celmisia densiflora*, *Senecio revolutus*, *Anisotome aromaticum*, *Ourisia caespitosa*, *Geum parviflorum*, *Senecio Lyallii*, *Celmisia coriacea*, *Cardamine heterophylla*, and *Forstera Colensoi*. There are also a few other plants near the limit of the beech forest, such as *Aristotelia fruticosa*, *Clematis marata*, *Chrysobactron Hookeri*, *Lycopodium fastigiatum*, *Pimelea Gnidia*, *P. prostrata*, and *Polystichum vestitum*, together with *Poa Colensoi*, *Agropyron scabrum*, and *Aciphylla Colensoi*. At the head of a gully in which the beech forest creeps up to over 3,000 ft. there is a patch of several acres covered with *Senecio revolutus*. It is seldom one sees much bloom on this species, but this season (1913 14) must have been an exceptional one, as the area referred to, and also several similar patches on other parts, were such a blaze of yellow with the bloom of this plant at the time of our visit as to completely dominate the physiognomy of the mountain-side, the brilliant colour being visible for miles. The "steppe" continues to nearly 4,000 ft., when it gradually breaks into "alpine meadow," although the latter, of course, still contains much of the steppe association.

On the lower parts of the northern side of Mount Tennyson there is also a formation which would come under the heading of "steppe." The tussock grasses here consist almost exclusively of *Danthonia flavescens* and *Poa Colensoi*, with its variety *Poa intermedium*. Growing among these some *Agropyron scabrum* is found. A good deal of this face of the mountain had apparently been burnt about twelve months prior to our visit, and this possibly affected the association. The Nevis Valley was about 2,600 ft. above sea-level at the point where we commenced our ascent of the mountain, and consequently much of the usual lowland steppe association was missing. The commonest plants outside those mentioned were *Aciphylla Colensoi*, which was very abundant, although the plants were apparently just getting over the effects of the fire, and were consequently small. In

the damper places *Ranunculus lappaceus*, *R. Poppelwellii* (sp. nov. Petrie), and *Geum parviflorum* were tolerably plentiful.

On the other "steppe" situations of the Garvie Mountains the association is much the same as that described in speaking of the eastern slopes.

(4.) ALPINE MEADOW.

Under this heading most of the meadow above 3,500 ft. may be described, although, of course, specialization under "rocks and cliffs" and "bogs and swamps" will be necessary as regards a good deal of it. Over a large part of the meadow *Danthonia flavescens* is found, and also *D. crassiuscula*. The presence of either of these "tussocks" is evidence of relative dryness. The places where these are missing are almost invariably either damp or very wind-swept. Perhaps more time was spent by me on the portions around the Remarkable Gap than elsewhere, near which I camped for several days at an elevation of about 4,200 ft. Most of this country consists of rolling tussock ridges which contain immense bogs, and the tops are covered with great patches of schistose rocks, many of which are weather-worn into wonderful forms, and all of which give shelter to an interesting plant association. A little below the "Boggy Saddle," on the southern face of the Titans, there is a great field of *Celmisia coriacea*, the leaves being rather narrow and almost bronze in colour. This form is characteristic of the locality, although here and there plants with white tomentum are seen. The other plants in the association are *Senecio revolutus*, *S. Lyallii*, *Danthonia crassiuscula*, *Poa Colensoi*, and *Carpha alpina*. A considerable area has been burnt, but the above plants seemed at the time of our visit to be taking complete possession. Another form of *Celmisia* is also common both here and farther up the ridge. This has tolerably stiff leaves, but the tomentum on the upper side is loose and woolly, and varies in colour from a pure white to a bright bronze. Possibly this is a form of *Celmisia verbascifolia*, but the common form of that plant is also plentiful. Other plants in this locality are *Senecio bellidioides* and *Claytonia australasica*, the latter in great patches. As the saddle is approached the ground becomes wetter, and the following are added: *Phyllachne Colensoi*, *Drosera Arcturi*, *Carpha alpina*, *Oreobolus pectinatus*, *Drapetes Dieffenbachii*, *Anisotome* sp. (?), *Dacrydium Bidwillii*, *Dracophyllum uniflorum*, *Pentachondra pumila*, *Suttonia nummularia*, and *Coprosma repens*. At about 4,500 ft. there is an immense field of *Celmisia* among the tussocks. This is sufficient to completely dominate the association, giving a greyish-white appearance to the whole hillside. The principal species are *C. coriacea*, *C. verbascifolia*, and *C. petiolata*. Growing among these we discovered several forms which suggest possible hybridism between some of these larger forms and *C. longifolia*. These intermediate forms partook of the nature of the larger plants, but had narrow leaves, in some cases not more than 1·5 cm. in width and from 25 to 30 cm. in length. *Celmisia Lyallii* is also a very common plant, and in places forms great patches many acres in extent. Dotted throughout this association, especially where the ground is damper, are numerous specimens of an *Aciphylla*, about 6 in. high, peculiarly marked with transverse lines. This is the plant referred to *A. Traillii* by Cheeseman, but is, I think, distinct from the latter, which probably does not occur on the mainland. *Celmisia longifolia* var. *alpina* is also plentiful in the damp ground with *Plantago triandra*, *Uncinia pauciflora*, and *Carex pterocarpa* (?).

On a patch where the tussocks had been burnt an almost pure association of *Celmisia coriacea* was in possession, with a patch of *Aciphylla Colensoi*. On a dry open patch on the summit of a ridge I noted the following:

Celmisia linearis, *Veronica uniflora*, *Brachycome Sinclairii*, *Cotula dioica*, *Veronica Thomsoni*, *V. ciliolata*, and *Hectorella caespitosa*.

Near the Blue Lake there is a great quantity of *Aciphylla Monroi* in full bloom (29th December), with *Ranunculus gracilipes*, *R. foliosa*, and *R. novae-zealandiae*, including a form of the latter with 8 to 10 petals. The ground here is also carpeted in places with *Geum leiospermum*, while *Geum parviflorum*, *G. uniflorum*, and *G. pusilum* are also common.

Looking at the mountain-side near the Blue Lake, the association is dominated by *Celmisia verbascifolia*, which is so plentiful among the tussocks of *Danthonia crassiuscula* as to strongly mark the physiognomy. Other Celmisias are also common, the principal being *C. coriacea*, *C. densiflora*, and *C. subalpina* (plentiful). At this point the *Danthonia crassiuscula* begins to thin out, and its place is taken by *Poa Colensoi*, *P. intermedia*, and a form of the former which has very stiff leaves with pungent points and which Mr. Petrie distinguishes as var. *pungens*. *Agropyron scabrum* and *Festuca rubra* are also common, while *Danthonia pilosa* is fairly abundant.

Here and there patches of *Ourisia caespitosa* are also seen with *Senecio revolutus*, *Aciphylla Monroi*, *A. Colensoi* (rare), *Acaena microphylla*, *Polystichum cystostegia*, *Cardamine depressa*, *Cotula pyrethrifolia*, *Brachycome Sinclairii*, *Senecio bellidioides* (?), *Gentiana corymbifera*, *Veronica uniflora*, *Lycopodium fastigiatum*, *Dracophyllum prostratum*, *D. politum*, *Phyllachne Colensoi*, *Raoulia grandiflora*, *Lycopodium Selago*, *Celmisia laricifolia*, *Oreobolus pectinatus*, and *Gnaphalium Traversii*.

At the time of our visit in December, 1913, snow-patches were plentiful at 4,300 ft. in this locality. The association near the melting snow consisted chiefly of *Caltha novae-zealandiae*, which was abundant and in full bloom in several places almost under the snow, the flowers completely starring the ground, and being in many cases over 2 in. in diameter. *Celmisia subalpina* (?), crushed and damaged by the weight of the slipping snow-drift, was nevertheless putting forth buds, and in a week or two would be in full bloom.

At 4,700 ft. *Senecio bellidioides* (?) was to be seen in close round patches from 16 cm. to 36 cm. in diameter. This form has an almost glabrous small leaf, and may be a "new" species. On the sunny faces at this elevation there are only occasional tussocks of low stature, and the principal plants are *Aciphylla Monroi* (dominant), *Craspedia uniflora* var. with woolly leaves, *Gaimardia ciliata*, *Racromitrium lanuginosum*, *Veronica pulvinaris*, *Hymenanthera dentata* var. *alpina*, *Veronica Buchanani*, *V. ciliolata*, *Aciphylla Kirkii*, *Leucogenes grandiceps*, and *Hectorella caespitosa*. The top of the mountain above the Remarkable Gap, at about 6,000 ft., consists of a flattish meadow exposed to the south-west winds. It contains a remarkable association of close-growing wind-swept plants, in which I noted the following: *Aciphylla simplex*, whose round brownish cushions, from 18 cm. to 50 cm. in diameter, were dotted everywhere, and predominated, contrasting strongly with the grey schistose rocks; *Myosotis pulvinaris*, *Phyllachne Colensoi*, *P. clavigera*, *Raoulia Parkii*, *Donatia novae-zealandiae*, *Dracophyllum prostratum*, *Veronica Thomsoni*, *Haastia Sinclairii*, *Abrotanella inconspicua*, *Celmisia viscosa*, *Aciphylla Monroi*, *Veronica lycopodioides*, *Viola Cunninghamii*, *Celmisia laricifolia*, and *Ourisia glandulosa*, with a *Celmisia* which may have been a small form of *C. discolor* or an undescribed species.

Mount Tennyson.

On Mount Tennyson, at a height of about 4,350 ft., an open association is found, the principal plants being *Celmisia Lyallii*, *C. longifolia* var. *alpina*,

Claytonia australasica, Gentiana corymbifera, Epilobium chloraefolium, Aciphylla Kirkii, Geum leiospermum, Celmisia prorepens, C. argentea, Angelicum decipiens, and the small *Aciphylla* like *A. Traillii*, mentioned above as being probably new. In damper situations *Phyllachne* cushions are also plentiful. There is also an extensive area of *Veronica lycopodioides*, the plants being stunted in form and only about 30 cm. to 35 cm. high. Growing among these Veronicas are numerous specimens of *V. propinqua, Celmisia petiolata, C. subalpina, C. discolor, C. Lyallii*, and here and there patches of *C. coriacea*. In the wetter places *Aciphylla pinnatifida* is common. At 4,500 ft. great patches of *Celmisia viscosa* and *C. Lyallii* are found, together with *Veronica buxifolia* and *V. Buchanani*, and a form of whipcord *Veronica* which may be "new," but which was not in bloom at the time of our visit. In the damp and boggy places I noted *Pentachondra pumila, Drosera Arcturi, Chrysobactron Hookeri, Celmisia Sinclairii*, and *Ranunculus lappaceus*; while on drier ground *Brachycome Sinclairii, Epilobium chloraefolium, Senecio revolutus, S. southlandica, Helichrysum bellidioides, Leucogenes grandiceps*, and *Dracophyllum prostratum* are growing in abundance.

The association of the summit of Mount Tennyson is generally similar to that described above, except that the Veronicas mentioned are not growing at the higher levels. In a damp rocky situation near the summit the following association was, however, noted: *Ranunculus lappaceus* (abundant), *Ourisia sessilifolia, O. glandulosa, Celmisia laricifolia, C. argentea, C. petiolata, C. discolor*, and a *Veronica* which was either *V. Muelleri* or an undescribed species. On the south-west slopes the principal association is *Poa caespitosa, P. Colensoi*, and *Chrysobactron Hookeri*, with an occasional patch of *Celmisia coriacea*. On the damper hillside lower still there is an abundance of *Veronica buxifolia* and *Dracophyllum prostratum*, with *Senecio Lyallii* plentiful on the creek-banks.

East Dome.

On the East Dome, after emerging from the subalpine scrub, the principal vegetation consists of low *Pteridium esculentum, Coriaria ruscifolia, Gaultheria antipoda*, and *G. rupestris*, scattered through which are numerous specimens of *Gentiana Grisebachii, Celmisia Sinclairii, C. petiolata, Lycopodium fastigiatum, Veronica buxifolia, V. Traversii* (?), *Coprosma crassifolia, Olearia nummularifolia, Brachycome Sinclairii*, and *Veronica propinqua*. Farther up the following appear: *Celmisia verbascifolia, C. coriacea, Poa caespitosa, C. colensoi, Danthonia crassiuscula, Veronica Buchanani, Pimelea sericeo-villosa* (?), with *Phormium Cookianum* and in rocky situations *Anisotome Haastii* and *Senecio Haastii*, the latter being particularly abundant, and having exceptionally large leaves, in one case noted the measurement being 27 cm. by 21 cm. without the petiole. The above association continues up the mountain, and may be taken to be typical.

(5.) ROCKS AND CLIFFS.

Much of this range of mountains consists of great patches of wind-swept rocks and precipitous cliffs, and as these situations have their peculiar plant-growths, some care was taken in noting their principal associations.

At an elevation of 2,000 ft. on the ridge leading from Glenary Station there is a rocky patch subject to much wind, the plant association being as follows: *Festuca rubra, Blechnum penna marina, Senecio bellidioides, Leptospermum scoparium, Rubus australis, Hypolepis tenuifolia, Coriaria angustissima, Ranunculus lappaceus, Wahlenbergia saxicola, Lagenophora petiolata, Acaena microphylla, Chrysobactron Hookeri, Poa australis, Holcus*

lanatus, *Senecio Haastii*, *Olearia arborescens*, *Griselinia littoralis*, *Blechnum capense*, *Cyclophorus serpens*, *Coprosma brunnea*, *Senecio bellidioides*, *Nothopanax Edgerleyi*, *Styphelia Fraseri*, *Anisotome Haastii*, *Polystichum vestitum*, *Asplenium flabellifolium*, *Geranium microphyllum*, *Pimelea prostrata*, *Raoulia glabra*, *Pteridium esculentum*, *Aciphylla Colensoi*, *Lycopodium Billardieri*, *Gaultheria antipoda* var. *erecta*, *Polypodium diversifolium*, *Coprosma crassifolia*, *Asplenium bulbiferum*, and *A. Richardii*. Many of these are in sheltered crevices of the rocks, but in exposed places the foliage is clipped close and the plants are stunted in form.

In many places the rock association is the result of the shelter from wind afforded by the overhanging rocks, while no doubt the windy mountain-tops where many of the rocks are found prove to be too severe a habitat for the plants less equipped to stand xerophytic conditions, and the associations are therefore specially selected ones. This is illustrated at the Titan rocks, at 4,100 ft., where the association is *Anisotome intermedium*, *Forstera sedifolia*, *Claytonia australasica*, *Aciphylla Monroi*, *Polystichum cystostegia*, *P. vestitum*, *Leucogenes grandiceps*, *Helichrysum bellidioides*, *Acaena novae-zelandiae*, *A. sanguisorbae*, *Poa Colensoi*, and *Celmisia ramulosa*. All of these plants possess more or less adaptation to xerophytic conditions. In rocky places, at an elevation of about 4,700 ft., there is a change, and the following plants were added: *Celmisia prorepens*, *C. discolor* (?), *C. viscosa*, *C. sessiliflora*, *C. argentea*, and *Raoulia grandiflora*. A marked instance was noted of the manner in which *Celmisia prorepens* recovers from the effect of snow. Last season was a severe one, and much snow fell on these mountains. The drifts in the rocky situations now under notice were very deep, and the "slipping" of the mass of melting snow in many places apparently ground off the tops of the plants, leaving nothing but the rootstock. *Celmisia prorepens* grows in great patches several metres in diameter on the sloping sheltered sides of rocky situations, and was one of the chief sufferers. A strong new growth of leaves had sprung up on every plant with such formal precision that many large patches looked like so-many gardener's lined-out beds, the plants being quite regular in symmetrical rows about 6 in. apart. Buds were forming, and in a short time the whole patch would apparently be in full flower. On the cliff-faces and rocky plateaux near Blue Lake *Celmisia ramulosa* is tolerably plentiful, and associated with it are *Cardamine fastigiata*, *Celmisia discolor* (?), *Senecio revolutus*, *Lycopodium Selago*, *Hectorella caespitosa*, *Anisotome Haastii*, *Veronica uniflora*, *V. Thomsoni*, *V. ciliolata*, *Drapetes Dieffenbachii*, *Ourisia glandulosa*, and *O. caespitosa*.

On rocky ridges at an elevation of about 5,000 ft. the following are the common plants: *Cardamine depressa*, *Asperula perpusila*, *Aciphylla simplex*, *Celmisia discolor* (?), *C. densiflora*, *C. viscosa* (abundant), *C. Lyallii* (in groups), *Taraxacum magellanicum*, *Raoulia Parkii*, *Senecio revolutus*, and *Danthonia crassiuscula*. At 5,300 ft. great patches of *Celmisia viscosa* and *C. Hectori* appear, and *Aciphylla simplex* becomes very plentiful, and here and there are patches of *Ourisia glandulosa*. The following plants are also fairly plentiful: *Raoulia Buchanani*, *Dracophyllum prostratum*, *Senecio bellidioides* (?), *Myosotis pulvinaris*, *Phyllachne Colensoi*, *Veronica uniflora*, *V. Thomsoni*, and *V. dasyphylla*.

On the north side of the Remarkable Gap is the nearest approach to a shingle-slip in this locality. The loose schist is covered with snow all the winter, and the moving mass as the snow melts carries the shingle slowly with it. The principal plants are *Celmisia coriacea*, *C. subalpina*, *C. Hectori*, *C. sessiliflora*, *Senecio bellidioides* (?), *Angelica decipiens*, *Aciphylla Monroi*,

with occasional *A. Kirkii*. On the rock-faces and in the clefts near the top *Ranunculus Buchanani*, *R. pachyrrhizus*, *Veronica Petriei*, and *V. pinguifolia* are seen.

An association worth noting is that of an exposed hilltop near Gow's Lake. The cushion form is of a most marked order, no plant protruding a fraction beyond its neighbours, although the association is a mixed one. A close examination was made of a patch 1·3 metres square, and no less than twenty-four species were noted, the list being as follows: *Aciphylla Kirkii*, *Cotula pectinata*, *Veronica uniflora*, *V. lycopodioides*, *Ranunculus novae-zealandiae*, *R. lappaceus*, *Taraxacum magellanicum*, *Claytonia australasica*, *Viola Cunninghamii*, *Phyllachne Colensoi*, *Colobanthus Billardieri*, *Raoulia Parkii*, *Celmisia argentea*, *C. linearis*, *C. subalpina*, *C. Lyallii*, *C. laricifolia*, *Abrotanella inconspicua*, *Drapetes Dieffenbachii*, *Myosotis* sp., *Gnaphalium paludosum*, *Craspedia uniflora*, *Brachycome Sinclairii*, and *Epilobium* sp. The surrounding plants were principally *Celmisia Lyallii*.

The Nokomai Gorge, lying to the west of Mount Tennyson, at an elevation of 1,000 ft., is bounded by cliffs of possibly 300 ft. in height in places, succeeded by steep mountain-slopes above them. Over these rocks *Muehlenbeckia complexa* hangs in green masses, with here and there *Corokia cotoneaster* and *Nothofagus* trees, apparently clinging to the bare rock. Among the smaller plants the following are fairly plentiful: *Senecio Haastii*, *Anisotome Haastii*, *Celmisia petiolata*, *C. petiolata* var. *membranacea*, *Polystichum vestitum*, *Blechnum fluviatile*, *Aciphylla squarrosa*, *Veronica salicifolia*, *V. Traversii* (?), *Poa caespitosa*, *Wahlenbergia saxicola*, *Coriaria ruscifolia*, *Danthonia flavescens*, *Senecio bellidioides*, *Hypolepis tenuifolia*, *Chrysobactron Hookeri*, *Ranunculus lappaceus*, *Coprosma crassifolia*, *Carmichaelia subulata*, *Acaena pilosa*, *Clematis indivisa*, *Rubus australis*, *Olearia virgata*, and *Arundo conspicua*.

Here and there are patches of *Pteridium esculentum* and *Acaena sanguisorbae*, while near the stream *Muehlenbeckia axillaris* grows commonly among the tussocks, with *Oxalis corniculata*, *Rumex flexuosus*, and *Gnaphalium Traversii*. At a lower elevation in the valley there is a considerable increase in *Corokia cotoneaster*, which climbs up the rocky faces, giving a grey appearance to the landscape. Farther down still, *Griselinia littoralis* and *Carpodetus serratus* make their appearance among the rock-covering, along with *Aciphylla squarrosa*, *Celmisia discolor*, and *Blechnum penna marina*.

(6.) BOGS AND SWAMPS.

I have mentioned earlier in this paper that extensive bogs and swamps exist on the Garvie Mountains. It is in these wet peaty places that much of the most interesting flora is found. It is hard, of course, to define the point at which a swamp ends and a bog commences, and consequently many of the typical bog-plants are found in the much drier swamps, and in some cases even on he alpine meadow adjoining. Notwithstanding this fact, the water-content of the ground is the chief factor in the distribution of the wet-ground vegetation. A typical bog association is that in the peaty ground near the hut at Blue Lake. Round the drier edge of the bog there is a belt of *Celmisia longifolia* var. *alpina*, this being dotted over with the round hard cushion of *Gaimardia setacea* and *Phyllachne Colensoi*, the latter about 40 cm. in diameter and bright green in colour. Surrounding the bog there is almost invariably a meadow association of *Danthonia crassiuscula*. *Gentiana corymbifera* and *G. bellidioides* are usually dotted about, while *Gnaphalium Traversii* and *G. paludosum* are common. Irregular

cushions of *Oreobolus pectinatus* of varying size up to 1 metre in diameter are plentiful, and through these a small swamp-grass grows. *Drapetes Lyallii* is common. On the drier patches *Ranunculus gracilipes* paints the surface yellow with its bright blossoms. In very wet places *Sphagnum* moss abounds, and in situations like these great irregular patches show the rosettes of *Aciphylla pinnatifida*. This species differs from all other members of the genus in its habit of sending out underground stolons and springing from these. It thus increases rapidly by vegetative process. Patches from 1 to 2 metres in diameter will frequently be found, all connected underground, although the surface rosettes are well apart. In the wetter parts the bogs are almost black in colour, but here and there the dark ground is starred with the dwarf rosettes of *Gnaphalium paludosum* and covered with small patches of *Carpha alpina*. *Celmisia glandulosa* in a stunted form is also common, and where a *Danthonia* island appears *Celmisia coriacea*, or *C. Lyallii*, or both, will be found. *Luzula campestris* in one or other of its forms, *Juncus planifolius*, and *Viola Cunninghamii* are also plentiful, as also are *Drosera Arcturi* and the xerophytic moss *Racomitrium lanuginosum*.

In some places the drier edges of the bogs are dotted with small plants of *Brachycome Sinclarii*, *Epilobium rotundifolium*, and *Cotula pectinata*. In the drier part of the bog—which may be called swamp—the association is confined to *Celmisia longifolia* var. *alpina*, *Carpha alpina*, *Brachycome Sinclairii*, *Ranunculus gracilipes*, *Gentiana corymbifera*, *Gnaphalium Traversii*, *Oreobolus pectinatus*, *Plantago lanigera* var. *Petriei*, and a small form of *Craspedia uniflora*. Frequently this latter plant covers many square metres.

On what is known as Boggy Saddle there is a patch of dwarf *Dacrydium Bidwillii*, associated with *Dracophyllum uniflorum*, *Pentachondra pumila*, *Pimelea prostrata*, *Styphelia pumila*, *Dracophyllum prostratum*, and *Suttonia nummularia*. In some places *Euphrasia Dyeri* and *E. zealandica* are common, and the margins of bog-pools are brightened with the pretty blue flowers of *Utricularia monanthos*. Veronicas are sparingly found along the margins of the swamps, the following having been noted: *V. lycopodioides* and *V. buxifolia*, including the var. *prostrata*. A peculiar form of *Veronica* like *V. loganioides* is also plentiful, but it may be only a juvenile form of *V. lycopodioides*, although it has kept its open-leaved form in cultivation in my garden for about four years. The swamp and bog associations on Mount Tennyson do not differ materially from those above described, which are typical of these mountains.

Conclusion.

The investigation of the flora of these mountains has so far resulted in the listing of no less than 360 species, spread over 151 genera and sixty orders.

Several new or comparatively rare species and forms have been found, such as,—

Ranunculus Poppelwellii n.s. Petrie. Closely related to *R. Berggreni*, but, according to Petrie, quite distinct.

—— *novae-zealandiae* Petrie. Reported from only two localities in Cheeseman's Manual.

Aciphylla sp. Near to *A. Traillii*, but considered distinct by Cockayne.

—— *pinnatifida* Petrie. Discovered here by me about the same time as it was found by Mr. Crosby Smith on Princess Range.

Anisotome sp. Probably an undescribed species; related to *A. aromatica*.
Celmisia subalpina Cockayne. Related to *C. Haastii*.
Veronica Muelleri Buch., or an allied species. The flowers were nearly an inch in diameter. *V. Muelleri* has hitherto been reported only from Mount Aspiring.
— *Armstrongii* T. Kirk, or an allied species. Petrie considered it his var. *gracilior* of *V. Hectori*, but now thinks it distinct.
— *lycopodioides* Hook. f. With persistent juvenile form. Probably *V. cassinioides* of H. J. Matthews.
Geum uniflorum Buch. The most easterly habitat so far reported in Otago.
Several forms of *Celmisia* which have not yet been satisfactorily placed, including one whose leaves turn a dark reddish-purple in winter-time. The mountain-tops are covered with a great variety of xerophytic cushion plants, wind being the dominant factor in determining the association.

On the whole, the Garvie Mountains possess a rich flora, and further investigation will probably disclose many new forms and species.

LIST OF INDIGENOUS SPECIES NOTED.

(1.) PTERIDOPHYTA.

Hymenophyllaceae.

Hymenophyllum Tunbridgense Smith. Waikaia forest; rare.
— *multifidum* (Forst. f.) Sw. Forest; not uncommon.

Cyatheaceae.

Alsophila Colensoi Hook. f. Forest; rare.

Polypodiaceae.

Polystichum vestitum (Forst. f.) Presl. Not uncommon.
— *cystostegia* (Hook.) J. B. Armstrong. Not uncommon on rocks.
Asplenium bulbiferum Forst. f. Not uncommon in forest.
— *flaccidum* Forst. f. Not uncommon in forest.
— *flabellifolium* Cav. Rocks, East Dome; forest; rare.
— *Hookerianum* Col. Waikaia forest.
— *Richardii* Hook f. Forest, and in clefts of rocks.
Blechnum penna marina (Poir.) Kuhn. Common; forest and steppe.
— *capense* (L.) Schlecht. Common; forest and steppe.
— *fluviatile* (R. Br.) Lowe. Not uncommon; forest.
— *membranaceum* Mett. Forest; rare.
Hypolepis tenuifolia (Forst. f.) Bernh. Common in forest.
Histiopteris incisa (Thbg.) J. Sm. In open forest.
Pteridium esculentum (Forst. f.) Cockayne. Open heath; not common.
Polypodium Billardieri (Willd.) C. Chr. Tree-trunks and logs in forest.
— *diversifolium* Willd. Tree-trunks; not plentiful.
Cyclophorus serpens (Forst. f.) C. Chr. Rocky situations, in Waikaia forest and East Dome.

Gleicheniaceae.

Gleichenia Cunninghamii Hew. In beech forest; rare.

Osmundaceae.

Leptopteris hymenophylloides (A. Rich.) Pr. Beech forest; rare.

Ophioglossaceae.

Ophioglossum coriaceum A. Cunn. Dry hillside.

Lycopodiaceae.

Lycopodium Selago L. Rocky plateaux, above 4,000 ft.
— *Billardieri* Spring. Beech forest; epiphytic.
— *fastigiatum* R. Br. Dry heath.
— *scariosum* Forst. f. Waikaia; open forest.
— *volubile* Forst. f. Waikaia; open forest.

(2.) Spermophyta.

Taxaceae.

Podocarpus Hallii T. Kirk. Beech forest; not common.
— *spicatus* R. Br. East Dome forest.
— *totara* D. Don. Beech forest, East Dome; rare.
Dacrydium Bidwillii Hook. f. Subalpine scrub and boggy saddle.
Phyllocladus alpinus Hook. f. Common in alpine scrub.

Potamogetonaceae.

Potamogeton Cheesemanii A. Benn. Pools; not common.

Gramineae.

Microlaena avenacea (Raoul) Hook. f. Common in forests.
Hierochloe redolens (Forst. f.) R. Br. Common in forests.
— *Fraseri* Hook. f. Not common; in meadow.
Danthonia Cunninghamii Hook. f. Steppe above 2,000 ft.
— *Raoulii* Steud. Common below 3,500 ft.
— *flavescens* Hook. f. Steppe; not uncommon.
— *crassiuscula* T. Kirk. Abundant above 3,500 ft.
— *pilosa* R. Br. Fairly common in meadow.
— *semiannularis* R. Br. Fairly common in meadow.
Arundo conspicua Forst. f. East Dome, near river.
Poa caespitosa Forst. f. Abundant in lower steppe.
— *imbecilla* Forst. f. Not common.
— *Colensoi* Hook. f. Common in meadow.
— — var. *pungens* Petrie. Common at high elevations.
— — var. *intermedia* Cheesem. Common in meadows.
Festuca rubra L. Lower steppe; common.
Agropyron scabrum (R. Br.) Beauv. Throughout meadows.

Cyperaceae.

Scirpus aucklandicus (Hook. f.) Boeck. Swamps.
Carpha alpina R. Br. Common in swamps.
Schoenus pauciflorus Hook. f. Common in swamps.
Cladium Vauthiera C. B. Clarke. Swampy, wet places, Waikaia Valley.
Gahnia procera Forst. Wet places.
Oreobolus pectinatus Hook. f. Common in bogs and swamps.
Uncinia compacta R. Br.
— *Sinclairii* Boott. Common in forest.
— *riparia* R. Br. Common in forest.
— *rubra* Boott. In forest and in meadows.
— *filiformis* Boott. In forest; not uncommon.

Carex secta Boott. Lowland swamps.
— *acicularis* Boott. Boggy places.
— *ternaria* Forst. f. Damp lowland swamps.
— *pterocarpa* (?) Petrie. Alpine bogs.
— *dissita* Sol. Forest.
— *lucida* Boott. Swampy places.
Hypolaena lateriflora Benth. Mountain swamps.

Centrolepidaceae.

Gaimardia ciliata Hook. f. Alpine bogs.
— *setacea* Hook. Alpine bogs.

Juncaceae.

Juncus effusus L. Damp places.
— *planifolius* R. Br. Damp places.
— *pauciflorus* R. Br. Alpine swamps.
Luzula campestris D.C. Several varieties. Common in meadows.
— *pumila* Hook. f. Common in meadows.

Liliaceae.

Enargea parviflora Kunth. Wakaia Valley forest; not plentiful.
Cordyline australis (Forst. f.) Hook. East Dome.
Astelia linearis Hook. f. Alpine bog meadow, Blue Lake.
— *nervosa* Banks & Sol. Common in forest.
— *montana* (Kirk) Cockayne. Alpine meadow; plentiful
Phormium tenax Forst. East Dome.
— *Cookianum* Le Jolis. East Dome and (rare) in Waikaia Valley.
Chrysobactron Hookeri Col. Common in damp situation.
Herpolirion novae-zealandiae Hook. f. Damp patches in meadows
Arthropodium candidum Raoul. Not uncommon, Waikaia forest.

Iridaceae.

Libertia ixioides Spreng. East Dome.

Orchidaceae.

Thelymitra longifolia Forst. Common in open forest.
— *uniflora* Hook. f. Common in open forest.
Microtis unifolia (Forst. f.) Rchb. Common in steppe meadow.
Prasophyllum Colensoi Hook. f. Common in steppe meadow.
Pterostylis Banksii R. Br. Not common; in damp forest
— *australis* Hook. f. Not common; in damp forest.
Caladenia bifolia Hook. f. Abundant in Waikaia Valley forest.
Chiloglottis cornuta Hook. f. In forest; not plentiful.
Corysanthes rotundifolia Hook. f. Common in forest.
— *triloba* Hook. f. Common in forest.
Gastrodia Cunninghamii Hook. f. Fairly common in forest.
Adenochilus gracilis Hook. f. Fairly common in forest.

Fagaceae.

Nothofagus fusca Oerst. Abundant in upper forest.
— *Menziesii* Oerst. Abundant throughout.
— *Solanderi* Oerst. Abundant in upper forest.
— *cliffortioides* Oerst. Abundant in upper forest.

Urticaceae.

Urtica incisa Poir. In beech forest; common.

Loranthaceae.

Elytranthe Colensoi Engl. Common; epiphytic on *Nothofagus Menziesii.*
—— *tetrapetala* Engl. Common; epiphytic on *Nothofagus Menziesii.*
—— *flavida* Engl. Common; epiphytic on various beeches.
Loranthus micranthus Hook. f. East Dome forest.

Polygonaceae.

Rumex flexuosus Sol. Not uncommon; lowland.
Muehlenbeckia australis (Forst. f.) Meissn. East Dome forest.
—— *complexa* (A. Cunn.) Meissn. Common on border of forest.
—— *axillaris* Walp. Nokomai Valley; not uncommon.

Portulacaceae.

Claytonia australasica Hook. f. Common in alpine meadow above 3,500 ft.

Caryophyllaceae.

Colobanthus acicularis Hook. f. Plentiful in bogs.
—— *Billardieri* Fenzl. Not uncommon.
Hectorella caespitosa Hook. f. Common on rocky places.

Ranunculaceae.

Clematis indivisa Willd. In forests; not plentiful.
—— *marata* Armstr. Alpine scrub; rare.
Ranunculus gracilipes Hook. f. Abundant in swampy ground.
—— *hirtus* Banks & Sol. Not uncommon in forest.
—— *rivularis* Banks & Sol. Damp places; common.
—— *lappaceus* Sm. Common throughout.
—— *multiscapus* Cockayne. Not uncommon.
—— *novae-zealandiae* Petrie. Blue lake, 4,000 ft.; common.
—— —— var. with 10 petals. Blue lake, 4,000 ft.; common.
—— *Buchanani* Hook. f. Damp rocks above 5,000 ft.
—— *pachyrrhizus* Hook. f. Damp rocks above 5,000 ft.
—— *Poppelwellii* Petrie n.s. Mount Tennyson; swampy places.
—— *foliosus* T. Kirk. Not common.
—— *tenuicaulis* Cheesem. Not common.
Caltha novae-zealandiae Hook. f. Abundant near snow above 4,000 ft.

Magnoliaceae.

Drimys colorata Raoul. Comparatively rare in open forest.

Cruciferaceae.

Cardamine heterophylla (Forst. f.) Schultz. Abundant.
—— *depressa* Hook. f. Abundant above 3,500 ft.
—— *fastigiata* Hook. f. Rocky places above 4,500 ft.; rare.

Droseraceae.

Drosera Arcturi Hook. f. Common in alpine swamps.

Saxifragaceae.

Carpodetus serratus Forst. Not uncommon in forests.

Pittosporaceae.

Pittosporum tenuifolium Banks & Sol. Tolerably common in forest.

Rosaceae.

Rubus australis Forst. f. Common.
—— *subpauperatus* Cockayne. Common.
Geum parviflorum Smith. Abundant above 3,500 ft.
—— *uniflorum* Buch. Abundant at Blue Lake, 4,200 ft.
—— *leiospermum* Petrie. Very abundant, but local above 4,000 ft.
—— *pusillum* Petrie. Rare; near Blue Lake.
Potentilla anserina var. *anserinoides* (Raoul) T. Kirk. East Dome.
Acaena sanguisorbae Vahl. Common throughout.
—— —— var. *pilosa* T. Kirk. Common throughout.
—— *novae-zealandiae* T. Kirk. Common throughout.
—— *microphylla* Hook. f. Common throughout.
—— *fissistipula* Bitter. Above 4,000 ft.; rare.

Geraniaceae.

Geranium microphyllum Hook. f. Common throughout.
—— *sessiliflorum* Cav. var. *glabrum* R. Kunth. Common in steppe.
Oxalis magellanica Forst. Abundant above 4,000 ft.
—— *corniculata* L. Common up to 3,500 ft.

Callitrichaceae.

Callitriche verna L. In wet ditches, Waikaia Valley.

Coriariaceae.

Coriaria ruscifolia L. Common in subalpine scrub.
thymifolia Humb. & Bonpl. Common on creek-banks.
angustissima Hook. f. Not uncommon.

Leguminosae.

Sophora microphylla J. Mull. Rare in Waikaia Valley; more common East Dome.
Carmichaelia robusta T. Kirk. Common.
—— —— T. Kirk. Common on creek-banks.

Elaeocarpaceae.

Aristotelia racemosa (A. Cunn.) Hook. f. Forest; not plentiful.
—— *fruticosa* Hook. f. Subalpine scrub; rare.
Elaeocarpus Hookerianus Raoul. Waikaia Valley forest; rare.

Rhamnaceae.

Discaria toumatou Raoul. Dry places; common.

Malvaceae.

Gaya Lyallii J. E. Baker. Damp gullies; abundant.

Violaceae.

Viola Cunninghamii Hook. f. Common up to 6,000 ft.
—— *filicaulis* Hook. f. Not uncommon.
—— *Lyallii* Hook. f. In Waikaia Valley forest; rare.
Melicytus lanceolatus Hook. f. East Dome; not common.
Hymenanthera dentata (R. Br.) var. *alpina* T. Kirk. Alpine meadow; rare

Thymelaceae.

Pimelea prostrata Willd. (one or more of its varieties). Very common above 2,000 ft.
— — *Gnidia* Willd. Rare; one plant only, 3,500 ft.
— — *sericeo-villosa* Hook. f. Not uncommon. (Perhaps this should be *P. Lyallii* Hook. f. var.)
Drapetes Dieffenbachii Hook. f. Alpine bogs; common.
— — *Lyallii* Hook. f. Alpine bogs; common.

Myrtaceae.

Leptospermum scoparium Forst. Abundant in lowland situations.
Myrtus pedunculata Hook. f. East Dome; not common.

Onagraceae.

Epilobium tasmanicum Haussk. (by this is meant the species hitherto referred to *E. confertifolia*). Meadow; common.
— *alsinoides* A. Cunn. Forest.
— *pubens* A. Rich. Damp forest; common.
— — *pictum* Petrie. Dry situations; common.
Epilobium insulare Haussk. Not uncommon.
— — *rotundifolium* Forst. f. Alpine bogs.
Fuchsia excorticata L. f. Common in forest.
— — *Colensoi* Hook. f. Forest; rare.

Halorrhagaceae.

Halorrhagis depressa Walp. Not uncommon in alpine meadow.
—— *uniflora* T. Kirk. Not uncommon in alpine meadow.
Myriophyllum elatinoides Gaud. Pools; not uncommon.
Gunnera prorepens Hook. f. Swamps.
—— *mixta* T. Kirk. On damp banks, &c.

Araliaceae.

Nothopanax simplex Forst. f. Forests throughout.
— — *Edgerleyi* Hook. f. Forests throughout.
— — *Colensoi* (Hook. f.) Seem. Forests throughout.
Pseudopanax crassifolium (Sol.) C. Koch. Forest; not abundant.

Umbelliferae.

Hydrocotyle novae-zealandiae D.C. Abundant in damp places.
—— *asiatica* L. Abundant in damp places.
Apium filiforme (A. Rich.) Hook. Rare; open forest.
Oreomyrrhis andicola Endl. Swampy places; common.
Aciphylla Colensoi Hook. f. Fairly abundant, but local.
—— *squarrosa* Forst. Lowland-meadow association.
—— *Lyallii* Hook. f. Mount Tennyson; not common.
—— *Monroi* Hook. f. Abundant above 4,000 ft.
—— *simplex* Petrie. Abundant in rocky places above 5,000 ft.
—— *Kirkii* Buch. Not uncommon above 4,000 ft.
—— *pinnatifida* Petrie. Abundant in swamps above 4,000 ft.
—— sp. (probably undescribed species); referred in Cheeseman to *A. Traillii.* Abundant in wet places.
Angelica decipiens Hook. f. Not uncommon at high altitudes.
—— *Gingidium* Hook. f. Lowland; protected banks.

Anisotome Haastii F. Muell. Common on damp rocks.
— *aromatica* Hook. f. Common in swampy places above 4,000 ft.
— *brevistylis* Hook. f. Rocks above 4,000 ft.
— *pilifera* Hook. f. Not common.
— sp. Probably new; related to *A. aromatica.* Boggy Saddle.

Cornaceae.

Griselinia littoralis Raoul. Common in forest.
Corokia cotoneaster Raoul. Abundant, Nokomai Valley.

Ericaceae.

Gaultheria antipoda Forst. f. var. *erecta* Cheesem. Plentiful.
depressa Hook. f. Plentiful.
perplexa Kirk. Not common; subalpine scrub.
— *rupestris* R. Br. Comparatively rare; Mount Tennyson.

Epacridaceae.

Pentachondra pumila (Forst.) R. Br. Common; alpine boggy situation.
Styphelia pumila Hook. f. Alpine meadow; not plentiful.
Fraseri (A. Cunn.) F. Muell. Common throughout.
Dracophyllum longifolium (Forst. f.) R. Br. Not uncommon.
Urvilleanum var. *montanum* (?) A. Rich. Subalpine scrub.
uniflorum Hook. f. Rare.
prostratum T. Kirk. Common in bogs.
politum (Cheesm.) Cockayne. Common in bogs.

Myrsinaceae.

Rapanea Urvillei (A. D.C.) Mez. Forest; rare.
Suttonia divaricata (A. Cunn.) Hook. f. Beech forest: rare.
nummularia Hook. f. Dry peaty places, 4,000 ft.

Gentianaceae.

Gentiana Grisebachii Hook. f. Not uncommon; East Dome.
— *corymbifera* T. Kirk. Common; alpine meadow.
lineata T. Kirk. Above 4,000 ft.; rare.
bellidioides Hook. f. Damp peat; common.

Apocynaceae.

Parsonsia heterophylla A. Cunn. East Dome; common.
— *capsularis* R. Br. East Dome; common.

Convolvulaceae.

Calystegia tuguriorum (Forst. f.) R. Br. East Dome; abundant.

Boraginaceae.

Myosotis macrantha Hook. f. Rare.
— *pulvinaris* Hook. f. Not uncommon in rocky places.

Labiatae.

Mentha Cunninghamii Benth. Common in meadow.

Illecebraceae.

Scleranthus biflorus Hook. f. Not uncommon in mead ws.

Scrophularinaceae.

Veronica salicifolia Forst. f. Creek-banks; common.
—— *buxifolia* Benth. Abundant in meadows.
—— —— var. *odora* T. Kirk. Abundant in meadows.
—— —— var. *prostratum* Cockayne. In boggy places above 4,000 ft.
—— *Traversii* (?) Hook. f. Subalpine scrub. (This may be a form of *V. monticola.*)
—— *monticola* Armst. Subalpine scrub; rare.
—— *lycopodioides* Hook. f. Common above 4,000 ft.
—— *propinqua* Cheesem. From 2,500 ft.; common in subalpine-scrub association.
—— *epacridea* Hook. f. Above 4,000 ft.; rare.
—— *Buchanani* Hook. f. Rocky situations; not common.
—— *Petriei* T. Kirk. Rocky situations; rare.
—— *Thomsoni* Cheesem. Common; rocky meadow.
—— *pulvinaris* Benth. & Hook. Common; rocky meadow.
—— *ciliolata* Benth. & Hook. Common; rocky meadow.
—— *uniflora* T. Kirk. Common; rocky meadow.
—— *dasyphylla* T. Kirk. Rocky meadow; rare.
—— *Muelleri* (?) Buch. or n. sp. Mount Tennyson; not common.
—— sp. (a var. related to *V. lycopodioides*, but remaining more or less persistent in juvenile form); perhaps *V. cassinioides* Matthews (?). Swampy place, Blue Lake.
—— *Armstrongii* T. Kirk. Mount Tennyson; abundant.
—— *Hectori* Hook. f. var. *gracilior* Petrie. Mount Tennyson; fairly plentiful.
—— *pinguifolia* Hook. f. Rocky situation, "Gap."
Ourisia glandulosa Hook. f. Common in moist places and swamps.
—— *sessilifolia* Hook. f. Alpine meadow, Mount Tennyson.
—— *caespitosa* Hook. f. Common; alpine meadow, above 4,000 ft.
Euphrasia zealandica Wettst. Wet places on creek-bank at 4,000 ft.
—— *Dyeri* Wettst. Wet places on creek-bank at 4,000 ft.

Lentibulariaceae.

Utricularia monanthos Hook. f. Margins of bog-pools, Blue Lake.

Plantaginaceae.

Plantago Brownii Rapin. Damp places; not uncommon.
—— *triandra* Berggr. Boggy places; common.
—— *lanigera* Hook. f. var. *Petriei* Cheesem. Boggy places; common.

Rubiaceae.

Coprosma rotundifolia A. Cunn. Forest; not plentiful.
—— *areolata* Cheesem. Forest; not plentiful.
—— *parviflora* Hook. f. Creek-banks.
—— *cuneata* Hook. f. Alpine meadow; rocky places.
—— *crassifolia* Col. Margins of forest.
—— *repens* Hook. f. Alpine meadow; rare.
—— *foetidissima* Forst. Forest; not plentiful.
Nertera dichondraefolia Hook. f. Forest; rare.
—— *depressa* Banks & Sol. Forest; common.
—— *setulosa* Hook. f. Damp forest, Waikaia Valley.
Galium umbrosum Sol. Meadows throughout.
Asperula perpusilla Hook. f. Meadows throughout.

Campanulaceae.

Pratia angulata (Forst. f.) Hook. f. Meadows; not uncommon.
Wahlenbergia saxicola (R. Br.) A. D.C. Abundant throughout.
— *gracilis* (Forst. f.) A. D.C. Not plentiful.

Stylidiaceae.

Phyllachne clavigera (Hook. f.) Muell. Common in mountain bogs.
— *Colensoi* (Hook. f.) Berggr. Common in mountain bogs.
Donatia novae-zealandiae Hook. f. Common in mountain bogs.
Oreostylidium subulatum (Hook. f.) Berggr. Boggy places; common.
Forstera sedifolia L. f. Fairly common above 3,500 ft.
— *Bidwillii* Hook. f. Fairly common above 3,500 ft.

Compositae.

Lagenophora pumila (Forst. f.) Cheesem. Abundant in meadows.
— *petiolata* Hook. f. Abundant in meadows.
Brachycome Sinclairii Hook. f. Common from 3,000 ft. upwards.
Olearia virgata Hook. f. Subalpine scrub, Waikaia Valley.
— *ilicifolia* Hook. f. Subalpine scrub, Waikaia Valley.
— *arborescens* (Forst. f.) Cockayne and Laing. Common on creek-banks.
— *nummularifolia* Hook. f. Subalpine scrub, East Dome and Waikaia Valley.
— *avicenniaefolia* Hook. f. East Dome; not common.
— *odorata* Petrie. Waikaia Valley; not uncommon.
— *Hectori* Hook. f. Waikaia Valley; not uncommon.
Celmisia Sinclairii Hook. f. East Dome.
— *longifolia* Cass. Common.
— — var. Blue Lake; meadow.
— — var. *alpina* T. Kirk. Blue Lake; bog meadow.
— *linearis* J. B. Armstr. Near Blue Lake; not common.
— — var.
— *sessiliflora* Hook. f. Common above 4,000 ft.
— *argentea* T. Kirk. Near Gow's Lake, 4,500 ft.
— *ramulosa* Hook. f. Abundant on rock-faces above 4,000 ft.
— *densiflora* Hook. f. Not uncommon; alpine meadow.
— *discolor* Hook. f. Mount Tennyson.
— *subalpina* Cockayne. Common above 4,000 ft.
— *incana* Hook. f. Not common.
— *intermedia* (Petrie) T. Kirk. Not common; 4,500 ft.
— *petiolata* Hook. f. Common on alpine meadow.
— — var. *membranacea* T. Kirk. Common on alpine meadow.
— *verbascifolia* Hook. f. Common on alpine meadow.
— *coriacea* Hook. f. Common above 3,500 ft.
— *Lyallii* Hook. f. Abundant above 3,500 ft.
— *viscosa* Hook. f. Abundant from 5,000 ft. upwards.
— *laricifolia* Hook. f. Alpine meadow; not uncommon.
— *glandulosa* Hook. f. Moist places; common.
— *Petriei* Cheesem. (?). Alpine meadow (perhaps a hybrid).
— *lanceolata* Cockayne. Alpine meadow.
— var. intermediate between *coriacea* and *Lyallii*. Alpine meadow.
— *prorepens* Petrie. Rocky situations; abundant.
— *Hectori* Hook. f. Abundant above 5,000 ft.

Gnaphalium luteo-album L. Common.
— *collinum* Lab. Common.
— *trinerve* Forst. f. Not common.
— *Traversii* Hook. f. Boggy places; abundant.
— *paludosum* Petrie. Boggy places; abundant.
Raoulia australis Hook. f. Common.
— *lutescens* Beauv. Common, gravelly places.
— *glabra* Hook. f. Abundant.
— *Parkii* Buch. Common above 4,500 ft.
— *grandiflora* Hook. f. Common above 4,500 ft.
— *Buchanani* Hook. f. Rare; near Gow's Lake.
Helichrysum bellidioides (Forst.) Willd. Common.
— *filicaule* Hook. f. Common in meadows.
— *glomeratum* Benth. & Hook. East Dome; rare.
Leucogenes grandiceps (Hook. f.) Beauv. Common on rocks above 4,000 ft.
Abrotanella inconspicua Hook. f. Swampy places.
Cassinia Vauvilliersii Hook. f. Common up to 2,700 ft.
— — var. *rubra* T. Kirk. Common up to 2,700 ft.
Craspedia uniflora Forst. f. Common in alpine damp places.
— — var. with woolly leaves. Common in alpine dry meadow.
Cotula Goyeni Petrie. Alpine meadow.
— *pectinata* Hook. f. Abundant, alpine meadow.
— *pyrethrifolia* Hook. f. Not uncommon.
— *dioica* Hook. f. Not uncommon.
Erechtites prenanthoides (A. Rich.) D.C. Forest; plentiful.
— *scaberula* Hook. f. Forest, plentiful; not common.
Senecio southlandica Cockayne. Common.
— *Lyallii* Hook. f. Creek-banks; common.
— *elaeagnifolius* Hook. f. Waikaia Valley; subalpine scrub.
— *cassinioides* Hook. f. Waikaia Valley; subalpine scrub.
— *Haastii* Hook. f. Abundant, East Dome.
— *revolutus* T. Kirk. Abundant above 3,500 ft.
Taraxacum magellanicum Comm. Common.
Microseris Forsteri Hook. f. Not uncommon in steppe.
Crepis novae-zealandiae Hook. f. Alpine dry meadow.

Art. XV.—*Notes of a Botanical Visit to Herekopere Island, Stewart Island.*

By D. L. Poppelwell.

[*Read before the Otago Institute, 4th August, 1914.*]

On the 27th November, 1913, I visited this island, which lies in Foveaux Strait, about five or six miles from Half-moon Bay. As it is one of the few islands upon which *Senecio Stewartiae* grows, and is, moreover, the most northerly known habitat of both that plant and *Poa foliosa*, a few notes on the plant formations may prove interesting.

We approached the island from the south-west, and thus had an opportunity of viewing its physiognomy from the weather quarter. The coast from this side presents a series of rocky faces, only here and there traversable.

Just above high-water mark the rocks were covered with a white limy substance, but bare of plant covering. Above this white hue, which is washed by waves during high tides, the rocks were clothed with a grey-green mantle, composed principally of *Veronica elliptica* and *Olearia angustifolia*, both in full bloom. Here and there a patch of light green betokened the presence of *Histiopteris incisa*, which forms the main floor-covering of this isolated spot. Where the wind struck less directly a yellow spot or two revealed the existence of *Senecio Stewartiae* in the formation, the large yellow corymbose heads and dark-green leaves crowded at the ends of the branches contrasting strongly with the less-marked *Veronica elliptica*, which formed the basis of the association.

On a nearer approach the beautiful white bloom of *Olearia angustifolia* irresistibly caught the eye, the great abundance of blooms and the rounded form of the shrubs rendering the plant conspicuous. On this face neither *Olearia Colensoi* nor *Senecio rotundifolius*, although abundant elsewhere, were seen, a further evidence of the high wind to which these islands are subject.

Upon landing, a scramble up the steep slopes revealed a dark peaty soil undermined everywhere with burrows of the mutton-birds (*Puffinus griseus*) and other petrels,* and possessing a damp pungent odour, reminding one of a domestic fowlyard on a wet day. Growing under the *Veronica* and *Olearia* bushes were seen numerous isolated plants of *Carex trifida*, *Asplenium obtusatum*, and *Muehlenbeckia australis*, the latter with exceptionally large and succulent leaves but somewhat straggling form. On the rocky faces *Poa Astoni* was abundant, while here and there in the peaty crevices *Senecio lautus*, *Stellaria parviflora*, *Tetragonia trigyna*, *Blechnum durum*, and *Poa Poppelwellii* were noted. A few stunted plants of *Rapanea Urvillei* were also seen. Farther up some exceptionally strong plants of *Asplenium lucidum* and *A. lanceolatum* and *Poa Astoni* appeared, the two latter growing on a raised mound of their own dead leaves, both plants having the appearance of growing on caudices, the spaces between being bare and peaty and deeply marked with bird-tracks.

Once the top of the slope is reached the island presents a somewhat flat surface, traversed by comparatively open tracks, no doubt made by the thousands of sea-birds which annually breed on the island.

The ground-covering here was chiefly *Histiopteris incisa*, which grew plentifully but was somewhat stunted in form, the leaves showing evidence in their brown tips of their struggle with the wind.

The taller covering was almost entirely *Senecio Stewartiae* and *Veronica elliptica*, while here and there were patches of *Rubus australis* and *Muehlenbeckia australis*, with occasional plants of the large-leaved *Stilbocarpa Lyallii*.

Senecio Stewartiae is an open-branched shrub from 2 to 3½ metres high. Its lanceolate leaves are from 12 cm. to 18 cm. in length, thick and sticky, crowded towards the ends of the branches, and covered beneath with white tomentum.

The plants were in full bloom, and the large handsome flowers made the shrubs very conspicuous objects. This species seems to be the dominating one among the shrubby species on the higher parts of the island. A marked feature of the *Veronica elliptica* was that the great majority of the plants had *white* flowers, instead of the usual *bluish* ones which charac-

* *Pelecanoides urinatrix*, *Prion vittatus*, and *Prion turtur*.

terize it. In certain individual specimens, however, especially in sheltered situations, I noted deep-blue flowers. Here and there near the tracks I noted dull weather-worn patches of *Asplenium falcatum*, with patches of *Muehlenbeckia complexa*, *Hierochloe redolens*, *Pteridium esculentum*, and *Poa foliosa*, with the imported grass *Holcus lanatus*.

A few specimens of stunted *Weinmannia racemosa* and *Rapanea Urvillei* were also noted, along with *Dracophyllum longifolium* and *Coprosma areolata*.

At the eastern end of the island, which is the highest part, there appears to have been a fire some time ago. This apparently destroyed the scrub over an area of from 2 to 3 acres. A most interesting result has followed. The whole of the burnt part is now covered with a close and almost pure association of *Poa foliosa*, the tussocks being close together and about 1 metre in height, making progress a difficult matter. The grass is growing very strongly, and the flowering-heads are exceedingly numerous and of immense size.

Upon climbing through this grass I discovered numerous young plants of *Veronica elliptica* and *Muehlenbeckia australis*, with a few of *Rapanea Urvillei* and *Lepidium oleraceum* var. *acutidentatum*, while the ground was full of the burrows of the petrels. It would appear, therefore, as time goes on, the original plant association of the island will regain possession, and that the *Poa foliosa* is merely a temporary occupant of the ground.

The extraordinary spreading of this grass, which elsewhere on the island is only found in isolated "tussocks," suggests the possibility of its having an economical value, which might be worth investigating. At present practically nothing is known of its value as a fodder plant.

Conclusion.

The existence of the plant covering depends in the first place upon the high rainfall, the soft peaty soil being very spongy and damp for a considerable depth. On the other hand, there is little doubt that the traffic of the birds materially affects the plant-growth. The ground is everywhere drained and aerated by thousands of tunnels made by the nesting birds, while the soil is richly manured by the constant deposits of these petrels. Most of the plants have large masses of surface roots only, and the loose soil enabled even fairly large specimens to be lifted out of the ground with ease.

The distribution of the species depends chiefly on the wind factor, the only plants that can get a hold on the steep exposed sides being those specially adapted to resist transpiration, notably *Olearia angustifolia*, *Veronica elliptica*, and *Poa Astoni*.

The extraordinary spread of *Poa foliosa* I attribute to its abundant seeding habit, the rich soil, and the unimpeded light gained by the destruction of the scrub by fire. Its wind-resisting qualities are evident from the manner in which it grows on exposed subantarctic habitats.

ART. XVI.—*On a Pure-white Form of* Anas superciliosa *Gmel.*

By D. L. POPPELWELL.

[*Read before the Otago Institute, 4th August, 1914.*]

ALBINISM in a greater or less degree is a not uncommon phenomenon among New Zealand birds. The occurrence, however, of a pure-white form of the common grey duck (*Anas superciliosa*) is of sufficient interest to justify its being put on record.

Already several specimens of this species showing partial albinism and other variations have been recorded. Dr. Buller, in vol. 7 of the "Transactions of the New Zealand Institute," at p. 224, mentions a case of partial albinism, but seems to think that the specimen was possibly a cross with the common domestic duck. He has also, in the second edition of "Birds of New Zealand," mentioned several cases of partial albinism, and states that his son reported having seen a pure albino in a wild state. The specimen was not, however, procured. Mr. W. W. Smith* also describes several aberrant forms of variation tending to albinism. Mr. T. W. Kirk† records a similar instance in the case of the brown duck (*Elasmonetta chlorotis*).

The specimen that I have now set out to describe was shot by Mr. George Moffatt on the 21st June, 1914, at Cattle Flat, on the Mataura River. From what he tells me, it was associated with a flock of grey ducks, and had been seen several times by him. It was a good flier, and, except for colour, was not distinguishable from its associates, its flight and habits being the same. Immediately on its receipt by me I sent it to Dr. Benham, who agreed that it seemed to be an albino form of *Anas superciliosa*. He has since kindly sent me formal measurements of the bird, which are sufficiently near to those recorded by Buller to make identification practically certain. The following are the measurements taken :—

	Inches.
Total length from tip of beak to base of tail-feathers . .	20
Length of wing-quills	10
Length of bill along edge of upper mandible . .	2·25
Length of bill along edge of lower mandible . .	2·375
Length of tarsus	1·75
Length of mid toe and claw	2·5

The bird, on dissection, has proved to be a male. Its plumage throughout is pure white; eye, dark brown; legs and bill, yellow. In point of size and shape it differs in no way from the typical wild grey duck. This interesting specimen is in good condition, and has been stuffed and mounted. The owner has generously decided to present it to one of the public museums of New Zealand. For some time at least, if not permanently, it will be deposited in the Otago Museum.

NOTE.

Shortly after the above paper was read Dr. Benham kindly sent me the following communication which he had received from Mr. W. O. Kempthorne, of "Redmount," Key, via Lumsden. As the letter affords a

* "On New Zealand Ducks," Trans. N.Z. Inst., vol. 29, 1897, p. 252.

† "On some Additions to Birds in the Colonial Museum," Trans. N.Z. Inst., vol. 13, p. 235, 1881.

plausible explanation of the occurrence of the above-described albino duck, I gladly publish it as received :—

Writing on the 16th August, 1914, Mr. Kempthorne says, "I have just noticed a paragraph on page 9 of *Otago Witness* of the 12th August about an albino wild duck having been shot. I dare say you will be interested in a very probable explanation of this curiosity. At my mother's place ("Parkdale," Heriot) there is a large pond which for twenty years has been a sanctuary for the wild duck (it being on private property, and my mother's wishes that no shooting shall be allowed, have made it such). In wet weather hundreds of ducks gather there, and the ducks bred there make it their home. For years there were white tame ducks also, but they dwindled in number until only one drake remained. This drake mated with a wild grey duck that was unable to fly (or could fly very little) and necessarily had to live entirely at the pond. I remember four or five years ago coming on a mixed clutch of ducklings (whites and greys), but after seeing them two or three times I never saw them again, and concluded that a weasel had accounted for them. On a recent visit to "Parkdale" (three weeks ago) I saw an albino wild duck, and my brother said there were more than one. It could fly, as I made it my business to frighten it and see. Evidently the tame white drake and the crippled wild duck had mated again, and their progeny had lived. The distance between Heriot and Mataura in a direct line would be thirty-odd miles, and this would not be an excessive distance for the flight of a wild duck. The tame Indian runner duck and the wild grey duck mate without trouble, but this is the only case I have heard of a white tame duck mating with a wild grey duck. It would be interesting to test the case again on the wild grey ducks in the Botanical Gardens. The two ducks would have to be shut together continuously for a lengthened period to ensure a satisfactory result."

ART. XVII.—*On* Ascidioclava, *a New Genus of Gymnoblastic Hydroids.*

By Professor H. B. KIRK, M.A., Victoria University College, Wellington.

[*Read before the Wellington Philosophical Society, 26th October, 1914.*]

Plate I.

CHARACTERS OF THE GENUS.

Trophosome.—A creeping hydrorhiza, branching freely, gives rise to unbranching hydrocauli, each terminating in a hydranth. Hydranths with filiform tentacles not in definite whorls, but tending to be arranged in three or four whorls. Perisarc entirely wanting.

Gonosome.—Medusa buds produced in clusters near the base of the hydranth, whether becoming free or not at present uncertain; tentacles rounded.

Ascidioclava parasitica n. sp. Plate I.

Height of hydrocaulus and hydranth together, 2–3 mm. Tentacles of adult hydranth, 20 or more in number; average length of tentacles, 0·4 mm.; the widest part of the tentacle a little above the base, the tentacle then tapering to the tip, where the diameter is about half that of the widest part. Hydrorhiza branching freely and anastomozing, the branches becoming concrescent, with absorption of ectoderm and mesogloea at the points of contact, giving a continuous coenosarcal sheet. Endoderm of hydrorhizal

portion greatly developed, and cavities completely obliterated. Medusa buds shortly pedunculate, the hollow peduncle containing a prolongation of the gastro-vascular cavity. Gonads at present unobserved.

Ascidioclava parasitica presents in both trophosome and gonosome anatomical characters that seem to me of interest. I note here the most striking of these.

Trophosome.—The ectoderm shows great differences in the different parts. On the tentacles and the hypostome it is cellular, and presents no special features. Below the tentacles the ectoderm of the hydranth shows nuclei and fragments of nuclei arranged indiscriminately, often three or four deep. Cell-outlines have quite disappeared (fig. 2). In this part the ectoderm somewhat resembles that of *Clava squamata* as figured by Allman.*

Towards the base of the hydranth this thickened ectoderm thins out to form the thin non-cellular membranous ectoderm of the hydrocaulus. Through this membrane the outline of the bases of the endoderm cells, changed as noted below, can be seen, giving the appearance of a fine irregular network. The ectoderm of the upper surface of the hydrorhiza is thin and nuclei are sparse. On the lower surface, where it is in contact with the epithelium of the host, the ectoderm consists of columnar cells with very clearly marked outline (fig. 4). In no part of the organism have I been able to discover any trace of a chitinous secretion.

The mesogloea is everywhere thin, and almost membranous.

The endoderm of the hypostome comprises a large number of glandular cells, and these decrease in number towards the lower part of the hydranth (fig. 2). In the hydrocaulus the endoderm cells are reduced to large thin-walled vacuoles. Only occasionally can a shrivelled nucleus be found adhering to the cell-membrane. Towards the base of the hydrocaulus these gradually give place to living cells with highly granular protoplasm. These encroach upon the cavity until, at the very base of the hydrocaulus, it is completely obliterated. This obliteration of the cavity marks the hydrorhiza also, and when the dividing walls become absorbed there is a continuous sheet of endoderm surrounded by the thin mesogloea and the ectoderm (fig. 4).

The large vacuolated endodermal core of the tentacles is very well developed. These cells, like the clear endoderm cells of the hydrocaulus, usually contain each a single vacuole. Allman† says with regard to the central endoderm of tentacles, "It would seem that the solid axial tissue of the tentacles is in every instance separated by the mesosarc, not only from the ectodermal layer of the tentacles, but, by a duplicature of the mesosarc, from the endoderm which lines the body-cavity of the hydranth, as was first pointed out by von Koch in *Tubularia*." I can find no trace of such an arrangement here. The axial endoderm of the tentacles appears to me to rest unmistakably on the endoderm of the gastro-vascular cavity of the hydranth (fig. 2).

Gonosome.—Medusa buds are produced singly, or more often in groups of from two to four, near the base of the hydranth. I have not found more than one group on any hydranth. Material collected from October to December does not enable me to say with certainty whether the medusa becomes free. A single medusa better developed than the rest was found unattached, but it is possible that it became detached in the removal of the hydroid from its host. It still showed the scar at the point at which it had been attached.

* "A Monograph of the Gymnoblastic or Tubularian Hydroids," pt. i, pl. i, 1871.
† "Report on the Hydroida dredged by H.M.S. 'Challenger,'" p. x, 1888.

The medusa buds are shortly stalked, and the stalk contains a stomochord. There are four very short, blunt tentacles, one opposite the end of each radial canal. The medusa bud (fig. 5) is campanulate. The manubrium is pear-shaped, with the mouth at the narrow end. Scattered sparingly are enormous nematocysts, which are seen in section to project downwards into the mesogloea (fig. 6). Cross-section shows on the surface of the ex-umbrella four interradial grooves. In the detached specimen mentioned above small bodies are developing on the margin of the bell opposite the ends of these grooves. These bodies will probably prove to be statocysts.

The ectoderm of the ex-umbrella consists of flattened cells. At the extremity of the tentacles these give place to columnar cells, many of which are nematoblasts. The inner ends of these cells are dark with granules, but are not pigmented. There is probably no reason to regard these extremities of the tentacles as ocelli. Longitudinal section shows that the tentacle contains a central mass of cells that look much like nerve-cells; but these are cut off from the ectoderm by mesogloea. They are large vacuolated cells of the endoderm, with well-developed nuclei. The nuclei are surrounded by an envelope of protoplasm, from which envelope strands cross the vacuole to the opposite wall. The mass is in direct continuation with the endoderm that lines the radial canal, and is a specialized portion of the endoderm lamella. It is possible that the condition of these cells is preparatory to the hollow state of the tentacles that characterizes the *Clavidae*; but if a hollow were to be developed on lines at present suggested by the appearance of the section the result would be a hollow lined by mesogloea, which is not at all likely to occur. Longitudinal section taken between the radials shows no circular canal, which probably develops later.

The ectoderm of the sub-umbrella consists of columnar cells, differing in length. The result is an epithelium somewhat resembling in appearance the endoderm of the gastro-vascular cavity of the hydranth. The ectoderm cells about the mouth and the lower portion of the manubrium are columnar cells of great size, many of them nematoblasts.

None of the specimens sectioned show gonads, and it may be presumed that they are immature.

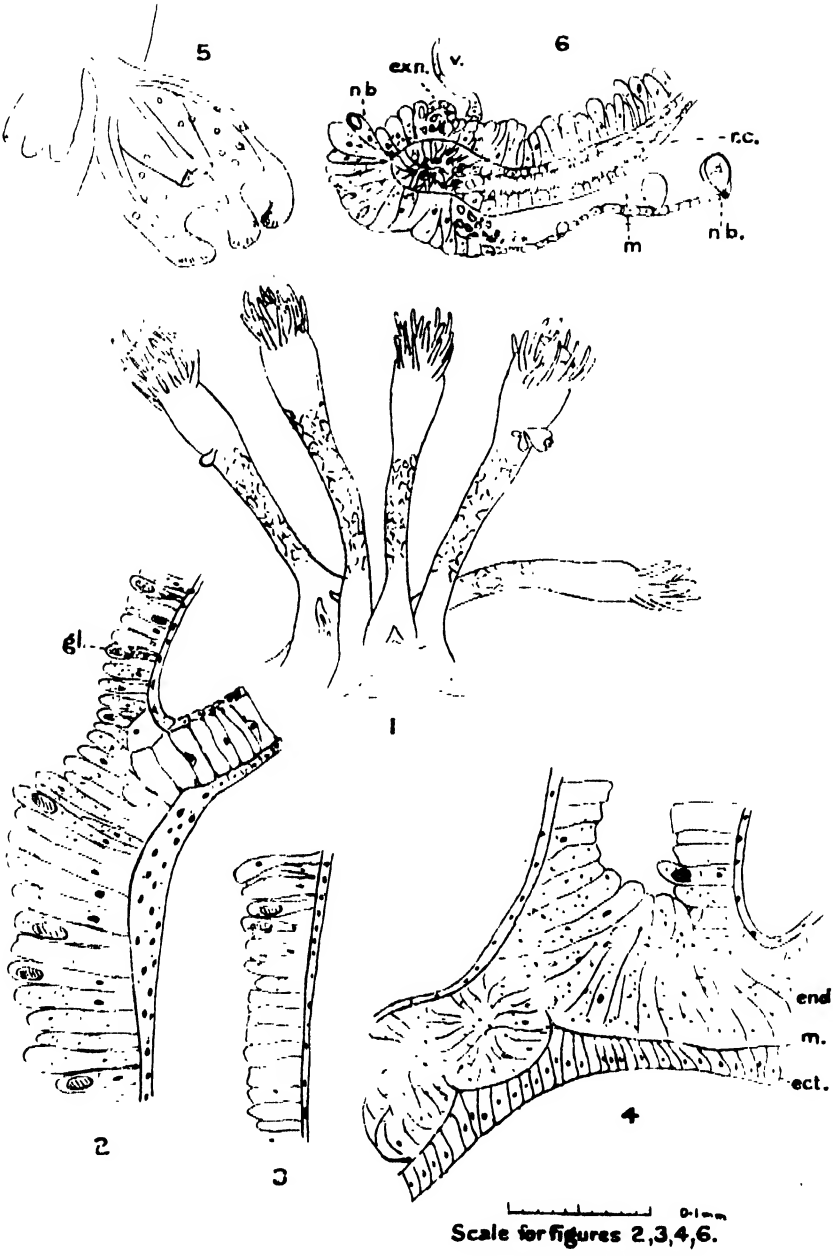
Ascidioclava parasitica is found in the peripharyngeal groove of an Ascidian (a species of *Polycarpa*) that occurs below low-water mark in Wellington Harbour. It, or an allied form, occurs sometimes, at all events, in the stalked Ascidian *Boltenia pachydermatina*. It is sometimes present in such abundance as almost to fill the peripharyngeal groove of the host. Attachment is very slight. I have frequently found small masses or detached portions in the pharynx of the host or in the stomach; but these were always dead and more or less macerated, or partially digested.

The infrequency of parasitism among the members of the class adds to the interest of this form.

All drawings made with Abbé apparatus.

EXPLANATION OF PLATE I.

Fig. 1. *Ascidioclava parasitica*, enlarged.
Fig. 2. Section of body-wall of hydranth. *gl.*, gland-cell of endoderm.
Fig. 3. Section of body-wall of lower part of hydranth and upper part of hydrocaulus.
Fig. 4. Section of base of hydrocaulus and adjacent portion of coenosarc. *end.*, endoderm; *m.*, mesogloea; *ect.*, ectoderm.
Fig. 5. Medusa buds.
Fig. 6. Section of tentacle and part of umbrella. *m.*, mesogloea; *nb.*, nematoblast; *v.*, velum; *ex.n.*, ex-umbral nerve ring; *r.c.*, radial canal.



Ascidioclava parasitica.

Face p. 148.

ART. XVIII.—*Some New* Coccidae.

By G. BRITTIN.

[*Read before the Philosophical Institute of Canterbury, 1st July, 1914.*]

IN the following paper are the descriptions of nine new species of *Coccidae*. With the exception of two species forwarded to me by my friend Mr. R. W. Raithby, from Crushington, near Reefton, they are the result of about eighteen months' consistent search in and around Oamaru. I have been reluctantly compelled to hold over several doubtful species, owing to the fact that the late Mr. Maskell's type collection is at present not available for reference, having been for the last six years in the United States, and also to his diagnosis and drawings of some species not being full enough for identification.

During the last few years the classification of the *Coccidae* has undergone a complete revision, and in accordance with the law of priority many long-standing names have been changed and new genera erected. For instance, the subfamily *Lecaniinae* has now been altered to *Coccinae*, and the genus *Dactylopius* to *Pseudococcus*. With numerous alterations of a similar nature, and the scarcity of good literature on the subject, a study of the New Zealand species is rather a difficult task. Apart from the late Mr. Maskell's work on the subject, apparently nothing is known of the New Zealand *Coccidae*, and that a thorough investigation into this important group of the *Hemiptera* will have to be made sooner or later there can be little doubt. Mr. R. Newstead, F.R.S., who is an authority on the English *Coccidae*, in a letter recently, says that "the whole question of redescribing the New Zealand species will have to be gone into again." This is becoming more necessary as new species make their appearance, and it is now known that some of the Australian species have, since Maskell's time, permanently established themselves in the Dominion.

The illustrations accompanying this paper have, as far as possible, been done on a uniform scale, and the approximate magnification has been given.

In conclusion, I beg to tender my thanks to Mr. C. B. Morris, F.R.M.S., of Oamaru, for the great assistance he has given me in my work; to Mr. R. W. Raithby, for the loan of some of the late Mr. Maskell's slides in his collection, and also for collecting; to Professor T. D. A. Cockerell, of Boulder, Colorado, and Dr. L. O. Howard, United States Entomologist, for literature on the subject; also to Professor R. Newstead, F.R.S., of Liverpool, England, and Mr. C. French, Victorian Entomologist, for much useful information.

Fam. COCCIDAE.

Subfam. DIASPINAE.

Gen. FIORINIA.

1. Fiorinia Morrisii sp. nov. Fig. 1.

Puparium of adult female consisting entirely of the second exuvia; elongate-ovate; generally straight, sometimes slightly curved; convex; colour light brown. Secretion white, felted; larval exuvia white.

Puparium of male felted, white, not carinated.

Adult female white, elongated, widest at cephalic extremity, convex. Rudimentary antennae with 4 strong hairs. Rostrum medium size, mentum almost circular, rostral setae short. Anterior spiracles, set very close to

rostrum, with group of 12–14 parastigmatic glands. Pygidium, broader than long, is very square across the lower extremity; 5 groups of circumgenital glands, the three upper groups forming a complete arch over the anal orifice; anterior group 20–24 glands; anterior laterals 25–30; posterior laterals 25–30; margin with 3 pairs of highly chitinized subequal

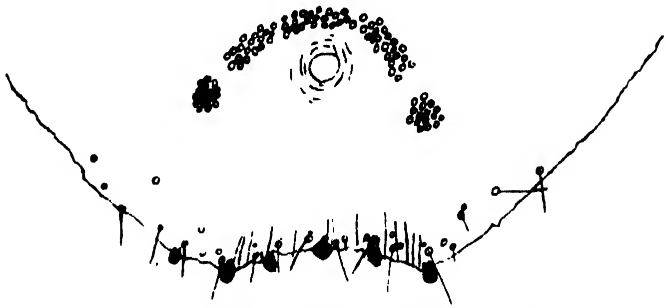


FIG. 1.—*Fiorinia morrisii.* Pygidium; × 200.

lobes, set equidistance apart; between each pair of lobes there are 2 long and 2 short spine-like hairs, with 3 more beyond the outer lobes. Several short spiny hairs scattered over the pygidium. Length, 1·30 mm.

Adult male unknown.

Hab.—On *Nothopanax* sp. and *Griselinia littoralis*, Oamaru.

Genus POLIASPIS.

2. **Poliaspis argentosis** sp. nov. Fig. 2.

Puparium of adult female elongate-ovate, convex. Secretion white, and closely felted; exuviae light yellow.

Puparium of male unknown.

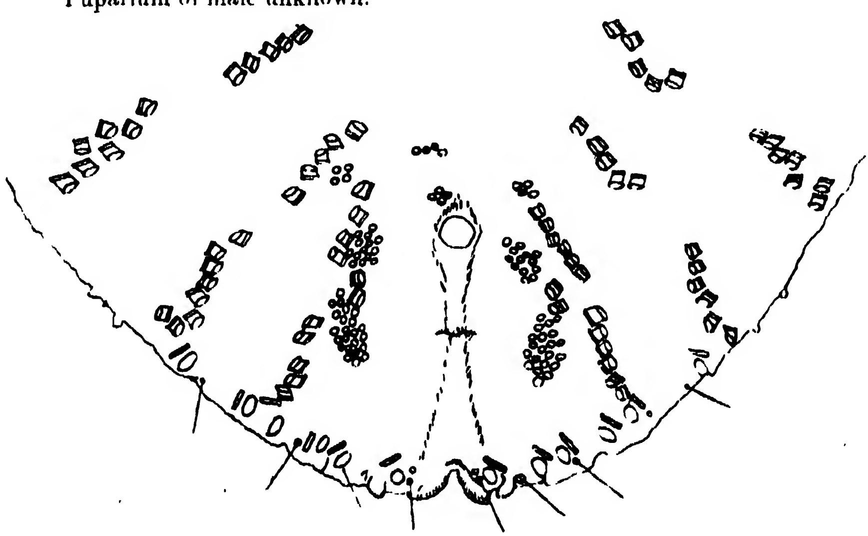


FIG. 2.—*Poliaspis argentosis.* Pygidium; × 200.

Adult female elongated, yellow, convex above, flat beneath. Rudimentary antennae with 2 long curved hairs at apex. Rostrum long, mentum

short and broad. Anterior spiracles with group of 6–10 parastigmatic glands; posterior spiracles with group of 4–6 glands. Last five free abdominal segments with short tubular spinnerets at side. Pygidium large and well defined, with 8 groups of circumgenital glands, the three anterior groups each consisting of 2–5 glands; subanterior group 2–4; anterior laterals 14–20; posterior laterals 21–25. Dorsal tubular spinnerets, in 8 distinct series, are short and cylindrical, and contain 4–6 spinnerets in each series; on the preceding segment there are 4 more series. The median lobes are narrow and widely divergent, with serrated edge; second pair long and narrow, and finely serrate; marginal spinnerets 6 on each side of median lobes, the four middle ones being in pairs. Plates, 4 on each side of median lobes, are simple and spine-like; the first three being situated between the median lobes and the first series of dorsal spinnerets, and one beyond. Spines 4, very short, one at the base of each plate. Anal orifice immediately below subanterior group of glands; vaginal opening centrally between posterior groups. Length, 1·22 mm.

Adult male unknown.

Hab.—On *Coprosma* sp., Crushington, near Reefton; found by Mr. R. W. Raithby.

This species is closely allied to *P. cycadis*, but differs in the shape and texture of the puparium, and also in the spinnerets on the pygidium.

Genus PINNASPIS Cockerell.

3. **Pinnaspis nitidus** sp. nov. Fig. 3.

Puparium of female elongate-ovate, convex, brown; exuviae terminal.

Adult female elongated, distinctly segmented, white. Rudimentary antennae bearing 4 fine hairs. Rostrum long and narrow, mentum short

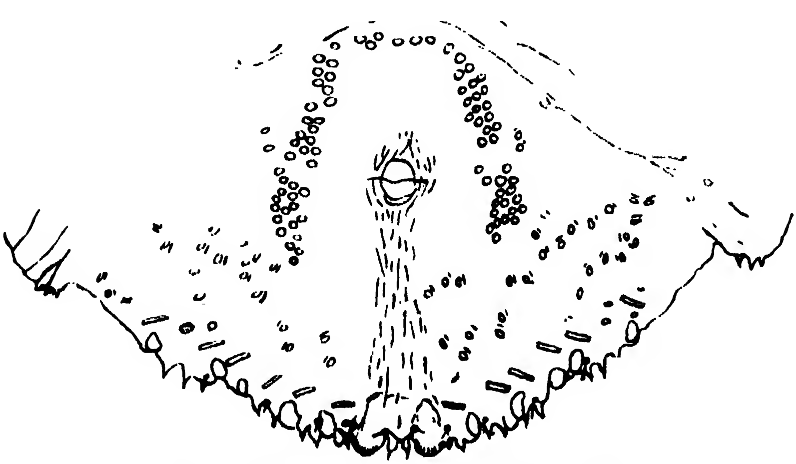


FIG. 3.—*Pinnaspis nitidus.* Pygidium; × 200.

and broad, rostral setae long. Anterior spiracles with group of from 4 to 6 parastigmatic glands. Last six free abdominal segments with numerous short tubular spinnerets at side. Pygidium medium size, with 3 pairs of lobes; median pair broad, widely separated, and with crenulated extremity: second and outer pair small and narrow. Between the lobes are 2 plates, which are short, thick, pointed processes, with 2 more beyond the outer

lobes. Spines, 4 on each side of, and 2 between, the median lobes. Marginal tubular spinnerets 6. Five groups of circumgenital glands, forming an almost complete arch; the number of orifices seem to vary a great deal, and the formula given here are for two specimens, that on *Pittosporum*—anterior group 6 orifices; anterior laterals 24, 19; posterior laterals 13, 13: and that on *Astelia*—anterior group 13; anterior laterals 24, 19; posterior laterals 14, 15. A few small oval spinnerets are scattered over the pygidium. Anal orifice and vaginal opening opposite, and situated centrally between the grouped glands. Last three free abdominal segments with group of 3 spiny hairs; cephalic extremity smooth and hairless. Length, 1·55 mm.

Hab.—On bark of *Pittosporum* sp. and on *Astelia*, at present only from Oamaru.

This species is very like *Lepidosaphes*, but, owing to the large second exuvia, must be placed in the genus *Pinnaspis*. I found on *Astelia* what is evidently the supposed male puparium, which agrees with Signoret's description; but, as the insect enclosed was not in the pupa stage, it was impossible to be sure of its true character.

NOTE.—The genus *Pinnaspis* has not hitherto been recorded as occurring in New Zealand.

Subfam. COCCINAE.

Genus LECANIUM.

4. **Lecanium armatus** sp. nov. Figs. 4, 4*a*, 4*b*.

Adult female ovate, dark-red, convex, with a distinct carina; margin with a row of strong spines; 2 irregular rows of slightly smaller spines along dorsum. Antennae of 7 joints, tapering towards apex, 4th joint longest; formula 4 (3, 2), 7, 6 (5, 1); all joints hairy, last joint with 2 very

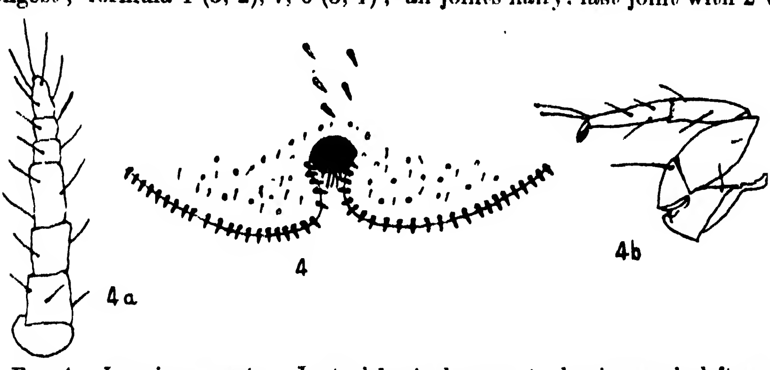


FIG. 4.—*Lecanium armatus.* Last abdominal segment, showing anal cleft and lobes with marginal and dorsal spines; × 120. 4*a*. Antennae of adult female; × 200. 4*b*. Leg of adult female; × 200.

long hairs and 8 short ones. Rostrum short, rostral setae short. Spiracles very thick, and barrel-shaped; anterior spiracles with several spinnerets immediately above, which, with others, form a band which slopes upwards towards the margin; posterior spiracles with a scattered group of the same immediately below. Legs small; coxa short and broad; trochanter large, and appears fused to the femur, which is short and broad; tibia narrow, dilated towards the tibio-tarsal joint; tarsus tapering towards claw, and slightly longer than tibia. Upper digitules long fine knobbed hairs; lower digitules broad. The coxa on the posterior pair of legs is abnormally

enlarged; all joints with several hairs. Anal cleft very broad, widening towards the lobes, which are highly chitinized, and shaped like two half-circles, between which is the anal ring, with 8 hairs; on the lower half of each lobe is 1 strong spine and several short hairs. Dermis covered with numerous short fine hairs and tubular spines. Length, 3·14 mm.

Adult male unknown.

Hab.—On *Muehlenbeckia australis*, Oamaru.

Subfam. DACTYLOPINAE.

Gen. PSEUDOCOCCUS.

5. **Pseudococcus oamaruensis** sp. nov. Figs. 5, *5a*, *5b*.

Adult female active, elongated, distinct segmented, convex above, flat beneath; colour brick-red; covered with a thin yellow meal. Antennae 8 joints, last joint longest; formula 8, 2 (3, 5), 1 (6, 7), 4; all joints with numerous long hairs. Mentum rather large, with hairs at tip; rostral setae medium length. Legs large and strong; coxa broad and short; trochanter narrow; femora long and thick; tibia long and slender, and about same thickness at both extremities; tarsus slender and about half length of tibia, narrowing towards the claw, which is long and thin; upper digitules long fine hairs, lower digitules slightly longer than claw, and club-shaped. Spiracles short and thick. Anal ring large, with 6 long hairs. Anal lobes

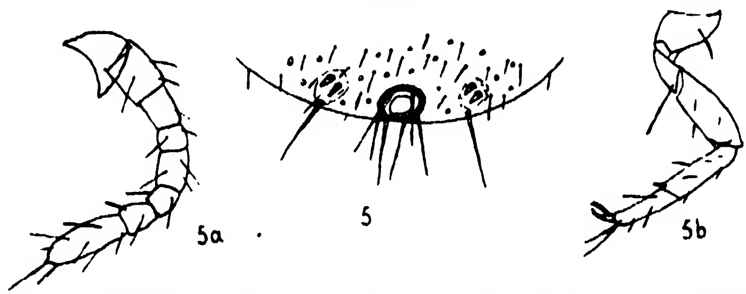


FIG. 5.—*Pseudococcus oamaruensis.* Abdominal segment with lobes and anal ring, dermis marked with spinnerets and hairs; × 120. *5a.* Antennae of adult female; × 200. *5b.* Leg of adult female; × 200.

inconspicuous, with 2 strong spines, several short fine hairs and 1 very long one. Dermis covered with numerous short fine hairs and spinnerets. The spinnerets are of two kinds—large simple, and the small multilocular. On the last few segments the small spinnerets appear as short tubes. Length, 1·6 mm.

Adult male unknown.

Hab.—Subterranean, on roots of *Aquilegia*, 3 in. to 6 in. beneath the surface.

6. **Pseudococcus cockayneii** sp. nov. Figs. 6, *6a*, *6b*, *6c*.

Adult female active, very elongated; colour pink; covered with a large quantity of white mealy secretion. Antennae of 8 joints, last joints longest; formula 8, 1, 2 (3, 7), (4, 5, 6); all joints hairy. Mentum very short and broad, with a few short hairs at tip; rostral setae short. Legs slender; tibia nearly twice as long as tarsus; digitules all fine hairs. Spiracles medium size, constricted in the middle; numerous large round spinnerets are grouped around spiracles. Anal ring very large, with 6 long hairs. Anal

lobes rather more conspicuous than usual, with 2 short thick spines and several long hairs, one hair being twice the length of the rest. On each segment are bands of long fine hairs, and spinnerets of two sizes, the large spinnerets being most numerous, small spinnerets being mostly on the

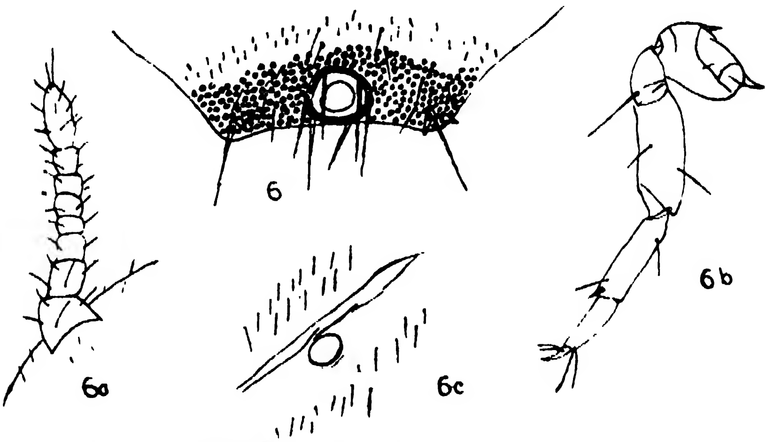


FIG. 6.—*Pseudococcus cockaynei.* Abdominal segment, showing lobes, anal ring with hairs, spines, and spinnerets; × 120. 6a. Antennae of adult female; × 200. 6b. Leg of adult female; × 200. 6c. Large circular markings on dermis; × 200.

ventral surface. Down the centre of the ventral surface, situated on the articulations between the segments, and starting on the third articulation from the posterior end, are 6 large circular markings, the first and last being smallest, the third and fourth the largest. Length, 2·93 mm.

Adult male unknown.

Hab.—On *Aciphylla*, around Oamaru.

7. Pseudococcus sexaspinus sp. nov. Figs. 7, 7*a*, 7*b*.

Adult female elongated, segmented, pale pink, enclosed in a test of white cottony secretion. Antennae of 8 joints, last joint longest; formula 8, 1, 2

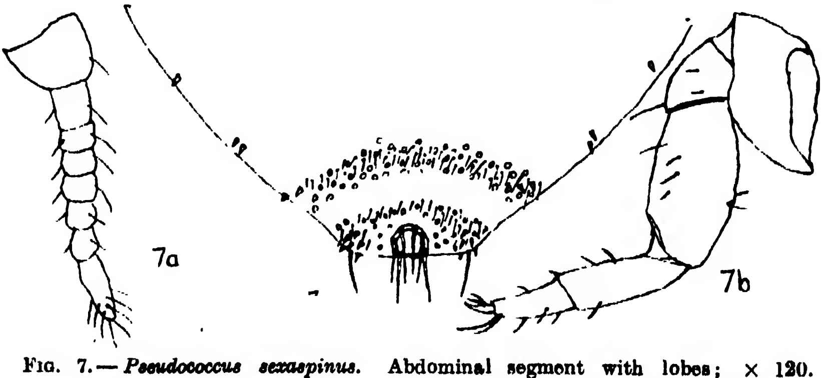


FIG. 7.—*Pseudococcus sexaspinus.* Abdominal segment with lobes; × 120. 7*a*. Antennae of adult female; × 200. 7*b*. Leg of adult female; × 200.

(3, 4, 5, 6, 7); all joints with several hairs. Eyes rather prominent. Rostrum normal; mentum long, timorous. Legs strong and thick; tarsus

shorter than tibia; all joints hairy; digitules all fine hairs. Anal lobes inconspicuous, with 6 short conical spines and several hairs, one hair being very thick and long; the two next preceding segments with 2 spines each, in pairs near edge of body, and the next segment with 1 spine; all segments marked out with bands of rather long hairs; cephalic extremity with numerous hairs between antennae; anal orifice with 6 long stout hairs. Dermis covered with numerous spinnerets. Length, about 3 mm.

Adult male unknown.

Hab.—Subterranean, on roots of sedge, at present only from Crushington, near Reefton; found by Mr. R. W. Raithby.

GENUS RIPERSIA.

8. **Ripersia occultum** sp. nov. Figs. 8, 8*a*, 8*b*.

Adult female active, elongate-ovate; colour dark purple; covered with a thick coating of yellow meal. Antennae medium length, of 6 joints, last joint longest; formula 6, 3, 1, 2, 5, 4; all joints hairy; articulations of antennae very pronounced. Rostrum short; mentum large and long, with hairs at tip; rostral setae short. Legs normal; tibia with 2 short spines at apex; digitules all fine hairs. Spiracles short and broad. Anal

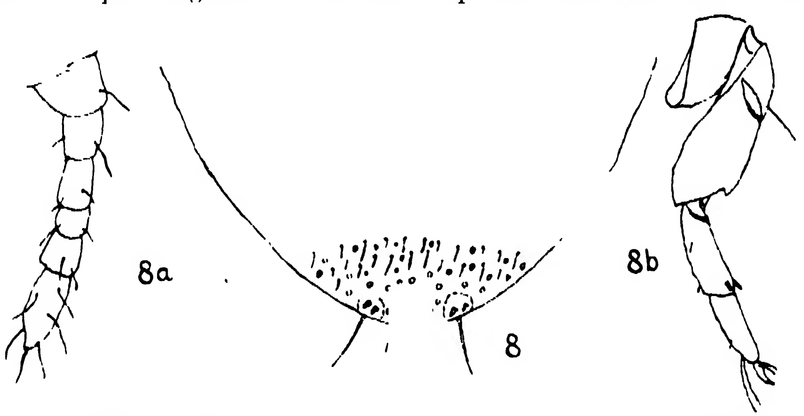


FIG. 8.—*Ripersia occultum*. Abdominal segment with lobes; × 120. 8*a*. Antennae of adult female × 200. 8*b*. Leg of adult female; × 200.

ring with 6 long stout hairs; anal lobes inconspicuous, with 2 short thick spines and several hairs, one of which is very thick and long. Dermis covered with long fine hairs, which are especially noticeable between the antennae. There are also numerous small circular spinnerets scattered over the body. On the abdominal portion, just above the anal ring, there are 9 large circular spinnerets arranged in the form of a circle. Length, 1·59 mm.

Adult male unknown.

Hab.—Subterranean, on roots of grass, 3 in. to 9 in. beneath the surface, Oamaru.

9. **Ripersia globatus** sp. nov. Figs. 9, 9*a*, 9*b*.

Adult female pink, globular, segmentation very indistinct, covered with a test of white cottony secretion. Antennae short, of 6 joints, last joint

longest; formula 6, 3 (2, 1), (4, 5); all joints except first with several hairs Mentum fairly long and pointed, with a few hairs at tip. Spiracles widely dilated at both extremities. Legs, like the antennae, very short; coxa short and broad; trochanter very large, with a single long fine hair; femora thick, with a few hairs on under-surface; tibia short and thick, with 2 short

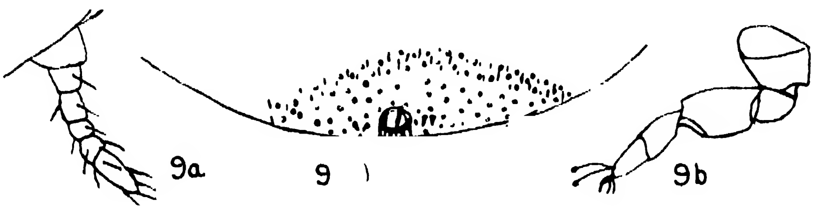


FIG. 9.—*Ripersia globatus.* Abdominal segment with lobes; × 120. 9a. Antennae of adult female; × 200. 9b. Leg of adult female; × 200.

spines near tibio-tarsal joint; tarsus slightly shorter than tibia, and more slender; upper digitules fine knobbed hairs, lower digitules fine hairs slightly longer than claw. The coxa on the posterior pair of legs is abnormally enlarged. Anal ring with 6 hairs, anal lobes imperceptible, represented merely by 2 short conical spines and a single long fine hair. Dermis covered with short fine hairs, interspersed with small round spinnerets. Length, 2·07 mm.

Adult male unknown.

Hab.—Subterranean, on grass-roots, moss, also in ants' nests; Oamaru.

ART. XIX.—*New Coccidae.*

By G. BRITTIN.

[Read before the Philosophical Institute of Canterbury, 2nd December, 1914.]

THE following paper contains the descriptions of one new genus and three new species of the New Zealand *Coccidae.*

The new genus *Scutare* will make a most interesting addition to the list of the New Zealand *Coccidae,* and has been placed temporarily in the subfamily *Conchaspinae,* to which it evidently belongs; and if it should ultimately be permanently placed in that subfamily a material alteration will have to be made in the diagnosis of the *Conchaspinae.* The species *fimbriata* varies in several important points from all the species belonging to the genus *Conchaspis* Cockerell. There is one genus of the *Conchaspinae* of which I am at present unable to get any information, that is the monotypic genus *Fagisuga** Lindinger. It may happen that my species belongs to that genus, but until I have received word from England and America I will leave it as at present placed.

* "Catalogue of *Coccidae,*" vol. ii, U.S. Dept. Agric., 1909, p. 35.

With regard to the species *Nudata*, this is placed in the genus *Cryptococcus*, which up to the present time has been a monotypic genus, the type being *C. fagi* Bärensprung, and to include the present species a material alteration will have to be made. In *C. fagi* the insect is covered with a loose cottony secretion, while *C. nudata* is, so far as I have been able to make out, entirely naked, and has 6 hairs on the anal ring, instead of 4 as in *C. fagi*. Both species have the distinguishing feature of the minute rudimentary antennae, and the equally small tuberculate processes which are mere vestiges of the posterior legs. Up to the present I have only been able to examine the adult female, but I hope shortly to hatch out some of the larvae.

The new species of *Fiorinia* I have much pleasure in naming after the late Mr. W. M. Maskell, who was the pioneer worker on the New Zealand *Coccidae*, and at the same time one of the leading men of his day on this subject.

Genus PINNASPIS Cockerell.

Pinnaspis nitidus mihi. Figs. 1 and 2.

In my last paper to the Institute I gave a description of the adult female, and also stated that I was not certain of the male scale. Since then I have been fortunate enough to get the male in the pupa stage, but, owing to moving to Christchurch shortly after, I was not successful in hatching any of the adult males. This is rather to be regretted, as I believe that the male of this genus has not yet been found. In figs. 1 and 2 will be found an illustration of both the male and female scales, and the difference between them can easily be seen.

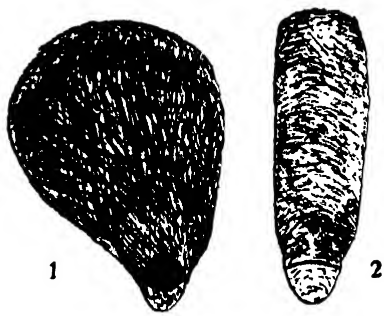


FIG. 1.—*Pinnaspis nitidus*. Female scale.
„ 2.— „ Male scale.

The following is the description of the male scale: Puparium of male elongated, with straight narrow sides; colour slightly lighter than that of the female; convex; closely felted; not carinated; exuvia rather large. Length, about 1·2 mm.

Subfam. DIASPINAE.

Genus FIORINIA.

Fiorinia maskelli sp. nov. Fig. 3.

Female puparium white; elongated; generally straight, sometimes curved; convex; first exuvia yellow, second exuvia brown, and entirely enclosing the insect.

Male puparium white; convex; elongated, with straight narrow sides; slightly shorter than that of the female.

Adult female white; at first elongate, but during gestation shrinking up until it has the appearance of an *Aspidiotus*; very convex; rudimentary antennae with 5 long hairs; cephalic extremity large, with a few short spiny hairs; anterior spiracles set very close to the rostrum, with a group

of from 18 to 20 parastigmatic glands; slightly above, and between the anterior spiracles and the edge of the body, are a group of short tubular spinnerets. Pygidium rather small and pointed, slightly chitinized, with 5 distinct groups of circumgenital glands; anterior group 15 glands; anterior laterals 23–34; posterior laterals 23–26; 2 pairs of lobes, the median pair being bilobed, the outer lobule being the smallest, the second pair of lobes very minute. Immediately above each lobe is a long spine-like hair, with 2 more beyond the outer lobes; there are several short hairs along the edge of the pygidium, 2 being between the median pair and 3 between the median and outer pair of lobes. There are no marginal tubular spinnerets, but 6 large scar-like markings appear on the lower end of the pygiduim, which has also a stirated appearance. Anal orifice situated well above the middle of the pygidium. Length, about 1·67 mm.

FIG. 3.—*Fiorinia maskelli.* Pygidium.

Female of second instar very similar to that of the second instar of *F. stricta*, but the dorsal tubular spinnerets are rather more numerous than in *F. stricta*.

Larva normal of the genus.

Adult male unknown.

Hab.—On *Plagianthus*, Oamaru: *Veronica* sp., Bluff: *Pittosporum* sp., Bluff, Oamaru, and Christchurch.

Subfam. CONCHASPINAE.

Genus SCUTARE gen. nov.

Puparium of female flat; more or less circular; fringed; ventral scale complete. Adult female retaining feet and antennae; anal ring setiferous; mentum biarticulate; terminal segments of the body somewhat resembling that of the *Diaspinae*.

Scutare fimbriata sp. nov. Figs. 4–10.

Puparium of adult female very thin; semi-opaque; appears to be of a dark-red colour, but is really white; glassy; ovate; surrounded by a broad white fringe; ventral scale complete.

Puparium of male pupa oblong; white; rather flat; loosely felted; completely enveloping pupa.

Adult female dark red; elongated; widest at cephalic extremity, and tapering towards the abdominal lobes. Eyes prominent, and situated at the inner base of the antennae. Antennae of 6 joints, tapering towards apex, third joint longest; formula 3, 6 (4, 5), (1, 2); apical joint with several hairs. Mentum biarticulate. Spiracles, in 2 pairs, are fairly large and ovate. Legs normal; coxa short and broad; femora thick; with 1 short hair at the junction of the trochanter; tibia short and thin, with small spine at the tibio-tarsal joint; tarsus almost twice as long as tibia; claw long and thin; digitules, two upper only observed. Abdominal portion of body very distinctly segmented, highly chitinized, and tapering towards the lobes, which are rather large and prominent. From the outer side of each lobe a narrow hyaline band converges towards the middle, and then runs directly upwards through the middle of the next four segments,

which it divides in halves, and which thus appear like 8 distinct plates, 4 on each side; the next immediate segment above is entire. Immediately above the lobes is a triangular segment left by the converging hyaline bands. The lobes are broad at the base, and chitinized, tapering sharply to the extremity; on each lobe there is 1 very long seta, and 3 long tubular spines;

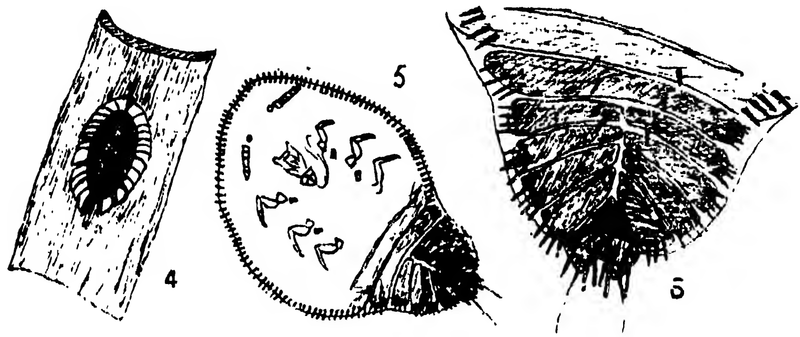


FIG. 4.—Insect on bark, showing fringe.
„ 5.—Insect after treatment with potash.
„ 6.—Abdominal segments, showing plates and spines.

between the lobes is the anal ring, with 6 long fine hairs. On each of the free abdominal segments, and somewhat within the margin, on the dorsal surface, are 4 long tubular spines similar to those on the lobes, and a row of these spines continue also round the edge of the thoracic portion of the

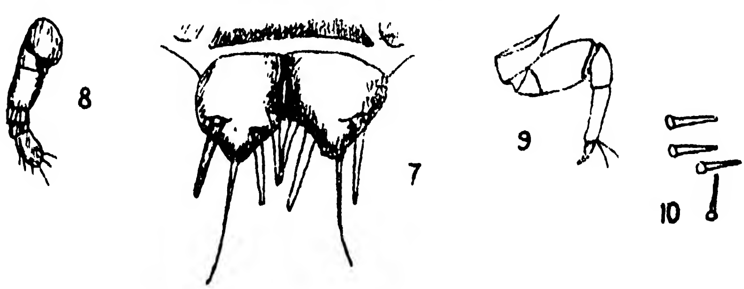


FIG. 7.—Abdominal lobes, showing anal ring.
„ 8.—Antennae of adult female.
„ 9.—Leg of adult female.
„ 10.—Marginal spines.

insect, but are longest towards the abdominal region; a double row of similar but smaller spines extends up the centre of the dorsal surface from the lobes to the fifth free abdominal segment. Numerous minute hairs and spines are scattered over the dorsal surface, also a few small circular spinnerets. Length, about 1·36 mm.

Larva short and ovate; colour light-red. Antennae of 6 joints, third and sixth joints equal and longest; formula (3, 6), (1, 2), (4, 5). Mentum biarticulate Legs normal; tarsus twice length of tibia. Anal lobes conspicuous, with 1 long seta and 3 long tubular spines. Anal ring large, with 6 hairs. Round margin of body is a row of long tubular spines, with 4 more rows extending up the centre of the dorsum.

This insect differs so much from all the known species of the genus *Conchaspis* that I have thought it best to place it under an entirely new genus for the present. Mr. Green,* in his book "*Coccidae* of Ceylon," diagnoses the genus *Conchaspis* as follows: "Scale elevated, more or less circular; adult female retaining feet and antennae, the latter of few joints; genital aperture without setiferous ring; mentum biarticulate; terminal segments of body united into a piece somewhat resembling the pygidium of the *Diaspinae*." Out of these seven characteristics of the genus *Conchaspis* two very important ones do not agree, and these are the elevated scale and the non-setiferous ring. In *S. fimbriata* the scale is flat and glassy, and appears like a *Ctenochiton;* the anal ring has 6 hairs, and the antennae have 6 joints, instead of 4 as in the genus *Conchaspis*, In fact, the insect appears to have a connection with the *Diaspinae*, with its definite pygidium; the *Ctenochiton*, with its glassy fringed scale; and the *Dactylopinae*, with its prominent anal lobes and setiferous ring.

Subfam. DACTYLOPINAE.

Genus CRYPTOCOCCUS Douglas.

Cryptococcus nudata sp. nov. Figs. 11–14.

Adult female naked; globular; colour light yellow; rostrum small, mentum biarticulate, rostral setae medium length; spiracles 4, large and oval, with a circular ring of glands round opening; rudimentary antennae with 2 or 3 short hairs; anterior and intermediate pair of legs absent, posterior pair atrophied and represented merely by a short protuberance; anal ring large, compound, with 6 short hairs, and surrounded by what appears to be a broad chitinous plate, on which there are 6 short hairs

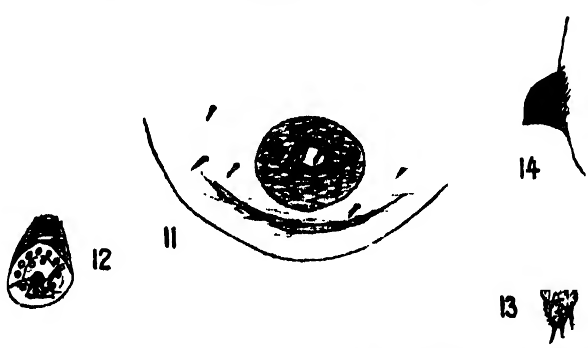


FIG. 11.—Abdominal segment, showing anal ring and chitinous plate.
„ 12.—Spiracle of adult female.
„ 13.—Rudimentary antennae of adult female.
„ 14.—Rudimentary leg of adult female.

—three on each side of the anal ring; abdominal lobes absent; dermis with a few minute hairs scattered over it. The dorsal surface of the abdomen appears to be more chitinized than the rest of the body. Length, about 0·7 mm.

Larva and adult male unknown.

Hab.—On *Hoheria* sp., Cashmere Hills, Christchurch.

* "*Coccidae* of Ceylon," vol. 1, p. 19.

ART. XX.—*Notes on some New Zealand* Polychaetes.

By W. B. BENHAM, D.Sc., F.R.S.

[*Read before the Otago Institute, 1st December, 1914.*]

THE identification and description of the marine Annelids from our shores was undertaken by the veteran zoologist Dr. E. Ehlers,* of Gottingen University, some years ago, and for that purpose I sent him representatives of all the species that I had collected up to that date. To this list I added a few more species as a result of the study of material obtained during the trawling expedition of the s.s. "Nora Niven"† and during the expedition to the subantarctic islands.‡ I hope to add to our knowledge of the group from time to time as I work out the large amount of material which I have accumulated in recent years.

On the present occasion I wish to make some remarks on three of the species described by Ehlers, for, as a result of an examination of more abundant material than was available to him, I have come to a somewhat different conclusion on certain points which affect the nomenclature.

After having found that I was unable to agree with Dr. Ehlers in regard to these points I wrote to him on the subject; and he was good enough to reply to me to the effect that, as I had at my disposal a more extensive series of specimens than he had, he was prepared to accept most of my conclusions.

Fam. SYLLIDAE.

Odontosyllis suteri sp. nov.

Eurymedusa picta Ehlers *partim* (Neuseeland. Anneliden, 1904, p. 21); *nec Eurymedusa picta* Kinberg, 1865.

I have examined specimens of a worm which agrees closely with the account given by Ehlers of *Eurymedusa picta* of Kinberg.§ The present specimens were collected by me at Portobello, in the Otago Harbour, and at Port Pegasus, in Stewart Island, and they are similar to that I sent to Ehlers from Tasman Bay. These agree precisely in their external features with Ehlers' description and figures, so that it came as a surprise to me to find that the pharynx is armed with a row of teeth which is characteristic of the genus *Odontosyllis*.

The long gizzard which extends from the 10th to 25th segment is preceded by a thick-walled pharyngeal tube (reddish in specimens preserved in formalin), the entrance to which is provided with a thick band of chitin stretching across the ventral margin, which bears 6 backwardly directed teeth. This band is rounded on its free surface, and on each side, beyond the row of teeth, is bent abruptly on itself, forming a rounded knob, from which there projects into the cavity a process which I at first took for a tooth in accordance with Ehlers' account, but further examination showed that it is merely the free end of the elastic band. Of the six teeth, the

* Ehlers. Neuseelandische Anneliden in Abhndl. Kgl. Gesell. Wiss. Gottingen, 1904, and pt. ii, 1907.

† Benham. Annelida, Sci. Results N.Z. Govt. Trawling Exped., 1907, in the "Records Canterbury Museum," vol. 1, 1909, p. 71.

‡ Benham. "Report on the *Polychaeta*, Subantarctic Islands of New Zealand," 1909, p. 236.

§ Kinberg. Annulata nova in Ofversigt af k. Vet. Akad. Forhandl., 1865, p. 249.

central four are similar to one another; the rectangular base of each is produced into a sharp narrow conical tooth; the lateral tooth on either side has a longer base, which is produced outwards towards the bay formed by the reflexed end of the chitinous band.

In one individual (preserved in formalin) the pharyngeal tube is widely open at its anterior end, and these teeth were fully exposed to view; but in another (preserved in alcohol) the entrance to the pharyngeal tube was

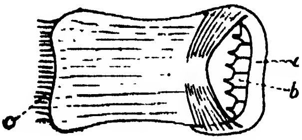


FIG. 1.

FIG. 1.—The pharynx of *Odontosyllis suteri* (enlarged). *a*, the chitinous band along the ventral margin of the entrance; *b*, the teeth; *c*, the junction with the gizzard.
FIG. 2.—The band, with its teeth. *a*, the reflected end.

closed, the anterior margin was reflected over it, and, owing to a right and left compression, the entrance was reduced to a narrow vertical cleft, so that the teeth were only rendered evident when the tube was slit open and the walls spread out.

Now, in Kinberg's diagnosis of his genus *Eurymedusa* we find the passage, "Maxilla unica, margine pyriformi, lateribus dilatatis, medio carinata," &c. There is, then, only a single tooth. It is true that Ehlers, in his account, speaks with some diffidence about the matter, for he says, "At the entrance to the pharyngeal tube is a long non-denticulated ring with a large tooth which appears as a pigmented fold projecting from the wall. Probably, however, this is only the swelling from which the true chitinous tooth has dropped away." His figure (pl. iii, fig. 9) is certainly not very convincing. I suspect that Ehlers mistook for a tooth the reflected end of the chitinous band. He was able to examine Kinberg's type specimen, and though he found certain differences in the character of the chaetae, and though Kinberg does not give a clear account of the peristomial flap which covers the prostomium, and though the state of preservation of the type did not allow him to study the everted pharynx, yet, in spite of these discrepancies, Ehlers identified our worm with Kinberg's.

It may be that the specimen from Laysan collected by Schauinsland and examined by Ehlers is really Kinberg's species; but those from the coast of New Zealand (one of which he received from Mr. Suter, from Christchurch, and others from me, collected at Tasman Bay) are, I have no doubt, identical with those which I have studied from other parts of our coast and from the Kermadec Islands.

Hence, as we have Ehlers' statement that his specimens are identical with Kinberg's, it is necessary to give a new specific name to this New Zealand species. I name it after Mr. H. Suter, who has done so much for New Zealand natural history, not only by his monumental monograph as a culmination to his extended work on our *Mollusca*, but also by his generosity in giving specimens of various animals collected by him to those engaged in the investigation of special groups.

Fam. CHLORHAEMIDAE.

Flabelligera bicolor Schmarda.

Pherusa bicolor Schmarda, Neue Wirbellose Thiere, 1861, p. 21, pl. xx, fig. 169. *Flabelligera lingulata* Ehlers, Neuseelandische Anneliden, 1904, p. 47. *F. semiannulata* Ehlers, *loc. cit.*, p. 150.

I received nine specimens of this species, and am able to add one or two notes to the account of Ehlers.

The two more carefully examined are 30 mm. and 50 mm. in length, with 55 and 58 segments respectively.

The body-wall is pale brown in the preserved state (in formalin), which is distinctly segmented in those specimens which are not distended with food. When this, however, is the case the anterior five or six segments show the segmentation as a prominent ridge at the anterior margin. Then the body commences to enlarge, and from the 8th to 16th the wall, hitherto thick and opaque, is thin and transparent, owing to the great amount of distension allowing the contained viscera to be seen and the muscular fibrillae to be distinguished in the wall itself. From this point the body gradually decreases in diameter towards the anal segment. In such a specimen, which resembles that described by Ehlers under *F. lingulata*, the dimensions of a specimen of 50 mm. in length are: the peristomium is 1·5 mm. wide; the 7th segment about 2·5 mm.; and the greatest breadth is 6 mm., at about the 10th or 12th segment. At the 18th it is 3 mm., and at about four segments from the end 1 mm. wide. It is thus spindle-shaped.

But in those cases in which the gut is not distended the differences are much less; in a 30 mm. individual its width over the greater part is 2 mm., rather less at the peristomium and towards the hinder end.

In the distended state, also, the colour differs, for it loses its brown tint, and becomes, owing to the stretching of the wall, very dark bluish or black in the anterior half, excluding the first 4 5 segments, and, as the gut is loaded with sand, this may be mottled.

In one case in which this distension had attained probably its maximum the segmentation of the body-wall was still indicated by white transverse lines on the dorsal surface in the middle region, while at the anterior and extreme posterior ends the ventral ridges at the anterior end of the segments persist.

The body-wall is enclosed in a jelly of considerable thickness, which, however, diminishes when the specimen is placed in alcohol and left for a time. But the amount of jelly seems to vary in different individuals; in one specimen from Denham Bay the notopodial chaetae do not, or only just, project beyond it. It is traversed by very numerous thread-like papillae, which terminate in a swollen apex. These spring from the entire surface of the body-wall, and are especially abundant and long around the notopodial chaetae.

The dorsal surface of the body is rounded, the ventral flat.

The head is concealed by a nearly complete circle of long capillary chaetae, which constitute the cephalic crown, which is itself hidden by the jelly and papillae.

The chaetae project for a distance of 5 mm., equal to the length of the peristomium and five or six following segments. These chaetae, which agree in structure with the notopodials, are rooted in a narrow, upstanding, nearly vertical fold of the anterior wall of the peristomium, which forms a con-

tinuous collar (fig. 3); but the chaetae are in reality in four distinct fan-shaped groups, two on each side, which touch one another; though the two dorsal and two ventral groups are separated slightly in the median lines. Each group is contained in its own chaetophore, the lips of which project slightly beyond the collar, as a dorso-ventrally extended fold, parallel with its margin. The bases or roots of each of the four bundles of chaetae can be seen converging as golden lines within the collar to a point deeply removed from the margin.

These chaetae are not of uniform length, those on the sides being longest, those on the ventral being shorter than the dorsal ones. The chaetae are

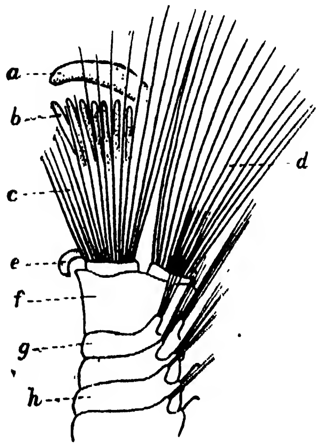


Fig. 3.

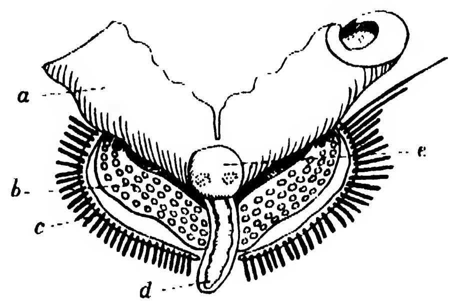


Fig. 4.

Fig. 3.—Side view of the anterior end of *F. bicolor* (enlarged). The surrounding jelly is not indicated. *a*, the tip of the palp (or subtentacle of Ehlers); *b*, tips of a few of the tentacles; *c*, dorsal bundle of peristomial chaetae; *d*, ventral bundle; *e*, median dorsal tentacle, or "lingula"; *f*, peristomium (the "chaetigerous lamella" projects beyond its edge); *g*, the 1st chaetigerous segment; *h*, the 3rd chaetigerous segment, bearing the hook in the ventral lobe of the parapodium.

Fig. 4.—View of the head from above, after the removal of the cephalic crown of bristles; the palps are cut across, and on the right side of the figure the groove along its ventral surface is represented. *a*, the palp; *b*, the tentacular platform from which the tentacles have been removed; *c*, the peristomial chaetigerous lamella bearing the bases of the bristles; *d*, the median dorsal tentacle, or "lingula"; *e*, the cerebral region of the prostomium, with pigment spots.

so closely placed at their origin from the chaetophores that they touch one another, and form a palisade through which it is almost impossible to see the enclosed tentacles and palps. The dorsal gap is wider than the ventral, except in very much contracted specimens, when the right and left groups overlap; but in less contracted condition the dorsal median tentacle projects through this gap as a tongue-shaped organ, or "lingula." At other times it may be found upright within the crown of chaetae. When this cephalic crown is pressed aside or cut away the organs of the head are exposed.

The tentacles, or branchiae, are numerous delicate filaments, densely crowded together in two dorsal groups, one on each side of the middle line. They are shorter than the palps, which are about three-quarters the length of the cephalic crown. Each group contains about 50 tentacles,

and when these are removed—they only too readily fall away when touched—it is found that they spring from a crescentic platform, which passes round within the collar from one lateral line to the other, outside the palp (fig. 4). In some cases the upper surface of the platform is nearly flat; at others this surface is directed inwards, and lies nearly in a vertical plane, due to the retraction of the apparatus. In one case in which the platform was flat I counted the bases of the tentacles: these are arranged in 4 concentric rows; the outermost, longest, presented about 20 attachment-spots; the next row 15; then 8; and the innermost 5. All these rows commence close to the dorsal mid-line, but only the two outer rows extend laterally outside the palp.

The dorsal median tentacle, or "lingula," is a greyish structure, grooved on its upper surface (really its inner face when not projecting outwards); it is a median thickening of the tentacular platform, beyond which it projects as a tongue-shaped organ, and is much wider than a branchial tentacle, and, unlike that, not readily detached.

The extent to which the "lingula" is visible depends on the state of preservation and consequent degree of contraction of the head organs. When these are strongly contracted and the whole head retracted it is almost impossible to detect the "lingula" without recourse to dissection.

Traced inwards this "lingula" is seen to pass on to the central or cerebral region of the prostomium, on which are two large pigment patches (? eyes) of variable size and irregular form. Beyond this again, towards the ventral surface, spring the pair of palps, which are longer than the tentacles, grooved on the ventral surface, with the lateral margins crinkled and overhanging. This groove leads into the mouth.

Following the peristomium, with its crown of chaetae, is a couple of chaetigerous lobes on each side, notopodium and neuropodium, directed forwards; these carry long capillary chaetae, which lie close alongside the crown. In the following segments the notopodium carries similar chaetae, but the neuropodium carries a hook.

The next two bundles of capillaries are also directed forwards. The notopodial and neuropodial lobes are short but distinct columns, the former provided with chaetophoral lips.

The notopodial chaetae are usually about 5 or 6 in number, which may be increased to 9 in the anterior bundles, but all are not of equal length or thickness; in the more posterior feet about four longer and one or two shorter. These chaetae are long, slender, and beautifully iridescent, rather brownish in colour when seen under the microscope, but on the body (seen by reflected light) are of a pale yellow, or silvery brass colour. They are finely and closely striated longitudinally, and crossed at intervals by distinct lines. Towards the apex these intervals are very long, but as the base is approached the lines become very close together.

The peristomial chaetae have the same appearance and structure, but differ in that the joint-lines are farther apart at the apex; the longest of them are about twice the length of the notopodial chaetae of the body.

The neuropodial hooks are solitary; only here and there in any of the worms do I find a second hook, either of equal length or only just protruding beyond the surface.

Viewed under a lens they are shining silvery yellow, with a dark-brown hook-shaped end, bent at nearly a right angle to the shaft, which projects far out of the body in all the specimens.

The plane of the hook is not in that of the shaft; it is "warped," as it were; the axis of the hook is itself bent, so that the tip lies in a different plane from the rest; hence when it is mounted and covered some distortion is almost sure to occur, if not even a slight rupture at the angle where the hook passes into the shaft.

The shaft is crossed by transverse lines or grooves at fairly regular and close intervals in the distal region, but lower down they are more widely distant. It is also densely striated in a longitudinal but slightly oblique

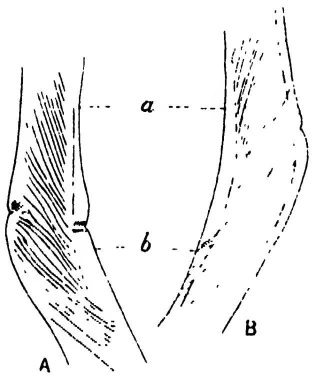


Fig. 5.

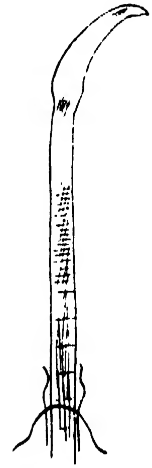


Fig. 6.

Fig. 5.—Portions of two hooks which were lying close together in a preparation (very highly magnified). The direction of the striations of the substance of the chaeta is disturbed in A, and at the margins the material is slightly ruptured, giving the impression of an articulation when seen under a lower magnification. The delicacy of these lines can scarcely be reproduced. *a*, shaft; *b*, the claw of the hook.

Fig. 6.—One of the ventral hooks from a Kermadec specimen, with the minute capillary bristles at its base. The "sheath" has been omitted. (All the figures of hooks were drawn by aid of the camera lucida.) This hook resembles Ehlers' fig. 5, pl. vii, of "*F. lingulata.*"

direction; these striae do not reach the surface of the chaeta. The claw-like end is similarly obliquely striated, and at the angle of bending a disturbance of the direction of these striations occurs (fig. 5). Sometimes there is a small notch on one or on both sides at this point; in other cases this is absent.

Each hook is accompanied by 4 very fine short capillaries, usually two above and two below it (as if it were an aciculum in an errant *Polychaete*). The free ends of these are curved, and lie close to the chaeta, and sometimes they may be concealed by the hook if one happens to cut off too much of the body-wall (fig. 6).

The hook and its satellites are enclosed in a transparent sheath of a cuticle-like structure. This is more readily seen in freshly mounted hooks than in those that have been long in glycerine. The sheath exhibits a corrugation at the surface of the chaeta, but is externally smooth: probably

it is purely cuticular. In one case at least I note that it surrounds the apex of the hook.

Distribution. -New Zealand, Chatham Islands, Kermadec Islands.

Remarks. I have described this worm at some length, in spite of the clear account given by Ehlers, because in one or two points that account seems to me to require extension. He described two species—*F. lingulata* and *F. semiannulata*—both from the Chatham Islands, and the latter founded on a single individual. And the differences between these two seem to me from a comparison of a large series of specimens from various localities to be individual rather than specific. In the first place, though he does not refer to this explicitly, the presence of the median dorsal tentacle, or "lingula," is not denied for *F. semiannulata*; no mention is made of it, and one may therefore presume its absence. The slight differences that he notes between the general form of the body and the condition of the head are, in my opinion, due to differences in the state of contraction—that is, the head as described for *F. semiannulata* is retracted to such an extent that in fig. 7 the bases of the peristomial chaetae are apparently within the projecting margin of the next segment, and the body as described for *F. lingulata* is much distended with food. I have shown above that this naturally makes a considerable difference in shape and in the clarity of the segmentation. But in his summary at the end of his account of *F. semiannulata* on p. 50 Ehlers lays more stress on the difference in the ventral chaetae, for he found two in each bundle in *F. lingulata*, and only one in the other species. In the latter it is accompanied by capillaries, which he did not find in *F. semiannulata*, and there is some difference in the angle formed by the claw on the shaft; the hook is said to be "far projecting," and the specific name apparently refers to the pseudo-articulation of the hook.

In addition to these specimens from the Kermadec Islands, I have a large number collected from various parts of the coast of New Zealand and from the Chatham Islands (whence Professor Ehlers obtained both his species). Now, all these agree in possessing a single hook (except occasionally here and there in a worm, when two may be present) enclosed in a sheath and of the form figured for *F. semiannulata*, but accompanied by capillary bristles; and also in the presence of a median dorsal tentacle, or "lingula."

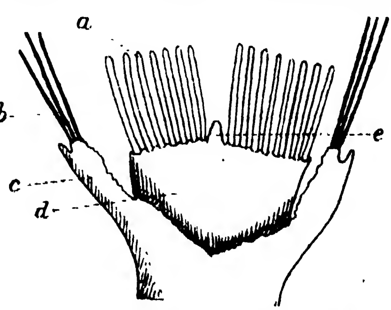


FIG. 7.—A specimen from Auckland. The peristomium has been slit up, so as to expose the tentacular platform and the "lingula." *a*, tentacles; *b*, peristomial chaetae (cut short); *c*, peristomium; *d*, tentacular platform; *e*, "lingula."

Some specimens from Auckland are particularly instructive: they are much contracted, having been preserved in strong alcohol; the head is withdrawn, and the gut protrudes through the mouth. At first I was unable to find the median tentacle, until I slit up the peristomium and reflected the chaetae of the crown; then it is recognizable, though relatively shorter than in uncontracted specimens (fig. 7). These Auckland specimens I had originally labelled "*F. semiannulata*," as they agreed so closely with the general account of that species given by Ehlers; but I find here, too,

that the single hook, which is far projecting and has the form characteristic for that species, is accompanied by the capillaries which are characteristic for *F. lingulata*.

In *F. semiannulata*, Ehlers says that the dorsal bristles are 5 or 6 in the mid and hind segments of the body, but more numerous in the anterior segments. On the other hand, he is less definite for *F. lingulata*; all he says is that they number 10, without any reference to the region of the body.

In these specimens from the Kermadec Islands I find the following numbers:—

	Specimen from Kermadec (*F. lingulata*).	Specimen from Auckland (apparently *F. semiannulata*).
Parapodium 1	8 long and short.	8 long and 1 short.
,, 2	– ,,	8 ,, 1 ,,
,, 3	,,	6 ,, 1 ,,
15	or 2 short.	6 ,, 1 ,,
40	or 2 ,,	4 ,, 2 ,,

Examination under a dissecting-lens will reveal only the long ones, since the shorter ones are also much finer.

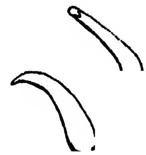
Ehlers had only a single individual of *F. semiannulata* on which to found his diagnostic characters, and it appears to me that he had before him merely a much contracted individual of *F. lingulata*.

When examining mounted preparations of the hooks of the Kermadec specimens I was puzzled to find that in some instances they resembled Ehlers' figure (pl. vii, fig. 5) of those of *F. lingulata*, and in other cases from the same specimen they recall those of *F. semiannulata* (Ehlers' fig. 9). It occurred to me that perhaps the act of covering, and the consequent pressure, might explain this difference. So I examined and drew under camera lucida some hooks mounted in water without a cover-slip; these exactly resemble those of *F. semiannulata*. When the cover was put on, and excess of water drained away, they recall Ehlers' fig. 4—that is, *F. lingulata*. I made several such preparations; in some cases the change was less obvious. I also drew the outlines, under the camera, of hooks from various individuals from the Kermadec and from the Chathams and from New Zealand, with rather surprising results, for sometimes on one and the same preparation (in glycerine-jelly) I found one hook like fig. 5 and another like fig. 9 of Ehlers' memoir. Sometimes the form is intermediate; that is, the angle—which for *semiannulata* is so marked, and for *lingulata* a very open one—is midway between them.

Another interesting case was a mount of a foot of a Kermadec specimen in which there are two hooks—a far-projecting one, and one that only just cuts through (text fig. 9). The longer one resembles Ehlers' fig. 5, the shorter approaches his fig. 9, though, as the hook was not flattened out as in other mounts, owing to the presence of the thick foot, the angle which the claw makes with the shaft is less marked than in Ehlers' fig. 9. Another apparent difference lies in the detailed outline of the claw—in his fig. 9 (of *semiannulata*) there is a slight swelling just above its union with the shaft, as in fig. 5 (for *lingulata*); it is absent in both his fig. 10 (*semiannulata*) and fig. 4 (*lingulata*).

Ehlers, in his second paper on our Annelids (1907, p. 21), quotes my note to him that accompanied the specimens of *F. lingulata* sent to him—that "in life it is partly greenish-blue and partly brown." This agrees with the coloured figure of Schmarda's *Pherusa bicolor*. And he also puts on record

the suggestion that I then made that I was "inclined to regard it as identical with that species." The renewed examination of this series of specimens from various localities and in various states of preservation confirms me in this opinion, so that both Ehlers' specific names must disappear and the older name replace them.



b *a*

FIG. 10.

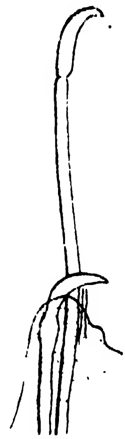


FIG. 8.

FIG. 9.

FIG. 8.—The end of a hook from the individual represented in Fig. 7: it resembles Ehlers' fig. 9, of "*F. semiannulata*."

FIG. 9.—A ventral lobe of another segment of the same individual, with two hooks. The shorter has a swelling at the base of the claw, and resembles Ehlers' fig. 5, representing *F. lingulata*; the longer one has a "pseudo-articulation," as in his *F. semiannulata*.

FIG. 10.—One and the same hook under different conditions. *a* was drawn mounted in water without a cover-slip; the tip of the claw is recurved, and lies in a different plane from the rest of the claw. *b* was drawn after being covered and some of the water drawn off by blotting-paper, so as to allow the cover-slip to press on the bristle; the apex is now pushed into the same plane as the rest; there is a slight swelling at the base, and a pseudo-articulation has appeared.

I may add that the following considerations have influenced me in arriving at this conclusion: It was the only Chlorhaemid that Schmarda obtained on the coast of New Zealand. He made his collections mainly in the neighbourhood of Auckland Harbour and the Thames. The only Chlorhaemid that I have obtained from that region (and, indeed, from elsewhere on our shores) is identical with those received from the Kermadec Islands. I have three different lots from that neighbourhood, and it would be against the law of chance that Schmarda should have collected any other than this common species and that I should not have received any of his species. Moreover, the dimensions and general form of body agree with *F. lingulata*. He gives 50 segments, with a length of 50 mm. and diameter of 8 mm. (which evidently includes the jelly). The anterior part of the body he describes as dark blue, the hinder as yellow-grey, and when the body is distended that is the coloration of our common species. He represents three bundles of long chaetae as directed forwards, and shows no tentacles or palps (which are drawn in the figures of the other two species on the same plate). This again is in agreement, for the cephalic crown conceals the tentacles, which are stated to be numerous and filamentous; and there are two, if not three, forwardly directed post-peristomial bundles of long

chaetae. He states that the chaetae surrounding the end of the body measured 6 mm. in length and are "*blassgelb*" in colour; the dorsal bundle of chaetae has rarely more than four (which is true when examined under a lens only); there is but a single ventral hook, the figure of which, crude as it is, is sufficiently like that of the present species. The few details that he gives, then, might well refer to our specimens. There is, however, one in which it appears to differ. Schmarda says that the dorsal chaetae are thicker than those of the cephalic crown, and have a greater number of transverse striations, since these are closer together in the former than in the latter. His figure shows no such difference in size, but his account of the striations agrees with what I find.

On the grounds, then, of probability, and of agreement in the general structure, it seems to me we must revive Schmarda's specific name for our common Chlorhaemid.*

Art. XXI.—*Preliminary Report on the Polychaetous Annelids from the Kermadec Islands.*

By W. B. Benham, D.Sc., F.R.S.

[*Read before the Otago Institute, 8th July, 1914.*]

Although a few deep-water Annelids were obtained by the "Challenger" in the neighbourhood of the Kermadec Group, no littoral forms have hitherto been recorded. Mr. Oliver's collection contains nineteen species belonging to thirteen genera, none of which agree with the species described by McIntosh in the "Report of the 'Challenger' Expedition."

Of these nineteen, only two species occur on the seashores of New Zealand—viz., *Odontosyllis picta* and *Flabelligera bicolor*. Two others have hitherto been found only in the Australian waters namely, *Lepidonotus simplicipes* and *Amphinome nitida*. Five are widely distributed throughout the Indo-Pacific oceans—*Eunice aphroditois*, *Lysidice collaris*, *Eurythoe complanata*, *Phyllodoce macrolepidota*, and *Lepidonotus glaucus*. There are two others with even a wider distribution—namely, *Eunice siciliensis*, which occurs in the Mediterranean as well as in the Indo-Pacific area; and *Hipponoe gaudichaudi*, originally obtained from the coast of Australia, has been met with as far away as the eastern coast of America. It is a rare species, and there are only three other records since its discovery.

I have found it necessary to found eight new species and one new variety, all of which, however, are more or less closely allied to Indo-Pacific forms.

I have not yet had the time to finish the drawings in illustration of these new species, so that in this preliminary note I refrain from naming them; for I hope to publish a detailed account of this interesting collection elsewhere, with full synonymy and references to literature.

* I had hoped that before this article was published I should have been able to convince Professor Ehlers of the justice of my conclusion, and while preparing the manuscript I posted a packet, containing samples from various localities, to Ehlers, and a letter asking him to compare them with the types of his two species. Unfortunately, war was declared before the packages reached England, and they were returned to me as "undeliverable."

LIST OF THE SPECIES.

Fam. AMPHINOMIDAE.

Amphinome nitida Haswell, 1879.

Locality.—Sunday Island : (*a.*) In husk of coconut cast ashore on Denham Bay beach, 25/6/08 (Oliver), thirteen individuals, of which Oliver writes : "Colour is slate, lighter below ; bristles white ; gills slate, tips reddish-brown." (*b.*) One specimen (R. S. Bell).

Distribution.—Cape Grenville, Queensland (Haswell).

It seems to be closely allied to, if not identical with, *A. jukesi* Baird, 1868.

Eurythoe complanata Pallas, 1766.

Locality.—(*a.*) Coral Bay, Sunday Island, one. (*b.*) Meyer Island, in rock-pools, three (2/2/08 and 19/5/08). Oliver states that it is "delicate pinkish white."

Distribution.—Very wide, in tropical and sub-tropical seas, where coral reefs occur. Indo-Pacific ; West Indies ; also Mediterranean.

Hipponoe gaudichaudi Audouin and Milne-Edwards, 1830.

Locality.—Sunday Island : "Cast up on Denham Bay beach, 19/10/08." Three individuals.*

Distribution.—Port Jackson (type) ; north of Bermuda ; also in north Pacific ("Challenger") ; at Woods' Hole, Massachusetts (Moore, 1903).

Fam. APHRODITIDAE.

Lepidonotus glaucus Peters, 1854.†

Locality.—Coral Bay, Sunday Island (Oliver) ; one female and one male (R. S. Bell).

Distribution.—Red Sea ; Philippines ; Ceylon ; Samoa ; Fiji ; Maldives ; Zanzibar.

Lepidonotus simplicipes Haswell, 1883.

Locality.—(*a.*) Coral Bay, Sunday Island (Oliver), eight. (*b.*) Sunday Island (R. S. Bell), five. (*c.*) Meyer Island (Oliver), five, "under stones amongst gravel."

Distribution.—Griffith's Point, Western Port, Australia (Haswell).

Sigalion sp. nov. ; affin. *S. amboinensis* Grube, 1877.

Locality. Denham Bay, Sunday Island, "dredged in 20 fathoms, on sandy bottom, 5/2/08" (Oliver) ; a single individual.

Fam. PHYLLODOCIDAE.

Phyllodoce macrolepidota Schmarda, 1861.

Locality.—Crater Rocks, Sunday Island (Oliver) ; "under stones near low water, 25/7/08." He notes that it is "green in life."

Distribution.—Philippines (Grube) ; Ceylon (Schmarda), (Willey).

Phyllodoce sp. nov. ; affin. *P. foliosopapillata* Hornell, 1903.

Locality.—Meyer Island ; one specimen.

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* See "Addendum" on p. 173.

† Ehlers (Z. Kenntniss d. Ostafrickan. Borstenw., 1897) has established the identity of the well-known *L. trissochaetus* Grube, 1869, with Peters's species.

Fam. Syllidae.

Odontosyllis picta (Ehlers, 1904). *Eurymedusa picta* Ehlers.

This species does not belong to Kinberg's genus *Eurymedusa*, as Ehlers supposed; he compared it with the type, but the state of preservation of that did not allow him to study the protruded pharynx. An examination of duplicates of the specimen which I sent to Ehlers shows quite clearly the row of denticles characteristic of *Odontosyllis*.*

Whether the specimen received by him from Schauinsland from Laysan is identical with our New Zealand species, of course I cannot say.

Locality.—Meyer Island, "amongst coralline algae, 24/4/08" (Oliver).

Distribution.—New Zealand (Ehlers).

Fam. Lycoridae.

Nereis sp. nov. (A); affin. *N. melanocephala* McIntosh, 1885.

Locality.—Sunday Island, Denham Bay beach; "washed ashore in husk of coconut, with *A. nitida*, 25/6/08"; three specimens.

Nereis sp. nov. (B); affin. *N. tongatabuensis* McIntosh, 1885.

Locality.—Meyer Island; "amongst coralline algae, 24/4/08"; four individuals in the "atokous" and two in the "epitokous" stage.

Nereis sp. nov. (C); affin. *N. masalacensis* Grube, 1878.

Locality.—Coral Bay, Sunday Island; five specimens.

Fam. Eunicidae.

Eunice aphroditois Pallas, 1788.

Locality.—Sunday Island (R. S. Bell). A fragment consisting of head and 40 segments.

Distribution.—Red Sea; Ceylon; Fiji; Philippines; Cape of Good Hope; Australia.

For synonymy see my report on the Annelids in "Scientific Results of the New Zealand Government Trawling Expedition" in "Records Canterbury Museum," vol. 1, No. 2, 1909.

Eunice siciliensis Grube, 1840.

Locality.—(*a.*) Coral Bay, Sunday Island; three specimens. (*b.*) Denham Bay beach; one. (*c.*) Meyer Island; one.

Distribution.—Mediterranean; Red Sea; East Africa; Seychelles; Maldives; Ceylon; Philippines; Juan Fernandez.

Eunice sp. nov.; affin. *E. medicina* Moore, 1903.

Locality.—Coral Bay, Sunday Island; three specimens.

Paramarphysa sp. nov.; affin. *P. longula* Ehlers, 1887.

Locality.—Sunday Island, Coral Bay; a fragment.

Lysidice collaris Grube, 1878. Var. **kermadecensis** var. nov.

Locality.—Coral Bay, Sunday Island; two complete individuals and four cephalic fragments; it is "green in life."

Distribution.—Red Sea; Ceylon; Philippines; Japan; Zanzibar.

Aracoda sp. nov.

Locality.—Coral Bay, Sunday Island; one specimen.

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* See article by myself in this volume (*ante*, p. 161).

Fam. CHLORHAEMIDAE.

Flabelligera bicolor Schmarda, 1861. (*F. lingulata* Ehlers and *F. semiannulata* Ehlers, 1904.)

Locality.—(*a.*) Coral Bay, Sunday Island; six specimens. (*b.*) Denham Bay, Sunday Island; one. (*c.*) Meyer Island, rock-pools; two.

Distribution.—New Zealand (Ehlers).

I have re-examined duplicates of those which I sent to Professor Ehlers, and have arrived at the conclusion that his two species are identical, but the individuals which he had at his disposal were in different states of preservation. I have written to him, and have received a reply in which he allows me, as having had abundant material to compare, to unite them. In my opinion Ehlers' name must give way to Schmarda's, who found only one species of *Flabelligera*, and as I have received specimens from the same locality as he found it—namely, Auckland Harbour—it is practically certain, in spite of the imperfect account given by him, that we are dealing with Schmarda's species, for I have received from all parts of our coasts only the one species of *Flabelligera*.*

ADDENDUM.

NOTE ON THE YOUNG OF HIPPONOE GAUDICHAUDI.

After writing the above summary I received from Dr. Chilton five small specimens of *Hipponoe gaudichaudi* which had been found by Mr. L. S. Jennings within the mantle-cavity of *Lepas anatifera*, from the Kermadec Islands. The worm has previously been found in association with barnacles. Thus Baird† (1868) refers to specimens then in the British Museum as having been found "amongst barnacles on a log of timber (? Madeira)," and to others from the neighbourhood of St. Helena as having been "concealed in the valves of *Lepas fascicularis*." McIntosh, also, in the "Challenger" Report (1885) records an individual "found adherent to *Lepas fascicularis* on the surface of North Pacific"; and Moore‡ (1903) found specimens on the under-surface of a log covered with *Lepas anatifera* which came ashore at Vineyard Sound, Woods' Hole. The worm, then, appears to have always been found on floating objects, to which they cling evidently by means of their powerful ventral hooks.

The interest of the present small specimens, which measure from 7 mm. to 14 mm. in length, lies in the fact that on most of them I noted some small brown bodies behind the dorsal chaetae, which I at first took for the gills filled with blood, till on touching them they fell away, and were then seen to be small annelids. They are a little more or a little less than 1 mm. in length by about 0·4 mm. across the middle part of the body, tapering to a blunt rounded end anteriorly and posteriorly. These spindle-shaped annelids are the young *Hipponoe*, which evidently cling to the body of the parent, and possibly wander over the body, for I found them sometimes between the bristles and the gill, more usually just behind the latter in the intersegmental furrow, sometimes more dorsally than the chaetae, at others rather more laterally; usually a single one at any spot, occasionally a couple together.

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* See article by myself in this volume (*ante*, p. 163).

† Baird, Linn. Soc. Journ., x, 1868, p. 239.

‡ Moore, Proc. Acad. Nat. Sci. Philadelphia, 1903, p. 793.

The young one consists of a rounded prostomium, followed by 6 chaetigerous segments, and a rounded anal segment, which is nearly as large as the prostomium.

The mouth lies between this and the 1st segment, which is not ventrally perforated by it as in the adult. The 1st segment bears only the dorsal bristles; the rest have the ventral hooks in addition. The dorsal chaetae, as in the adult, are long capilliforms, 3–6 in a bundle; the four ventral hooks, which are precisely like those of the adult, are sunk in a pit, but are capable of being protruded, as a slight pressure on these soft-bodied young ones readily demonstrates.

There are no gills, and the dorsal cirrus is at present represented by only a small spherical bladder-like structure just behind the ventral limit of the dorsal bundle of bristles.

It may be noted that Baird records that amongst his specimens several had "attached to their under-surface animals which are doubtless parasitic on them." It seems, however, to be likely that he had before him the young ones.

It is perhaps remarkable that all those *Hipponoe gaudichaudi* that have been examined microscopically have proved to be females. I found that to be the case; McIntosh and Moore both described their specimens as being distended with eggs. It seems, then, that the male is yet to be discovered, and no doubt the worm would repay anatomical study if we could get well-preserved material.

Art. XXII.—Oligochaeta *from the Kermadec Islands.*

By W. B. Benham, D.Sc., F.R.S.

[*Read before the Otago Institute, 7th July, 1914.*]

The only species of earthworm hitherto recorded from the Kermadecs is *Rhododrilus kermadecensis*, described by myself* in 1904, and this species was founded on a single specimen collected by Captain Bollons. It was therefore with feelings of interest that I received from Mr. Oliver a considerable number of earthworms which I expected would afford further material for determining the faunistic relations of the group of islands. Some of the smaller worms appeared on a first inspection to agree in general size and colour with *Rhododrilus*, and, owing to various calls on my time, I set the tubes aside till I was at liberty to examine them thoroughly. When, however, I came to investigate them it was with great disappointment that I found that all the earthworms belong to the family *Lumbricidae*, characteristic of the Northern Hemisphere, and to species which have been widely disseminated by human agency. This is the more surprising as but little cultivation has been carried on, for the only inhabitants have been Mr. Bell and his family. But while it is certain that these Lumbricids have been introduced, the exact means by which this introduction has been effected is not in all cases evident. It may be that the cocoons were amongst seeds imported for grass or vegetables or other plants, or perhaps they were in the material used for packing, or, if living plants have been imported into the Kermadecs from New Zealand with a fair amount of soil at the roots,

* Trans. N.Z. Inst., vol. 37, p. 298.

then it is possible that living worms were also present, provided that these were of small or moderate size. But similar importations have been recorded in many parts of the world—see Michaelsen (11)* and there is no doubt that it has occurred in this case.

In addition to the earthworms, or "megadrilous Oligochaets," Mr. Oliver also collected two species of "microdrilous" genera, and on a previous occasion I received another species from Captain Bollons. These belong to the two families *Enchytraeidae* and *Tubificidae*. The *Microdrili* are small in size, and the majority are aquatic in habit, and, owing to the fact that very little is known of the *Microdrili* outside North America and Europe, and of recent years India, it is impossible to use the facts in any discussion as to geographical relations of the islands. For instance, three species of Enchytraeids, all introduced northern forms, have been recorded from New Zealand by Beddard (5) and myself (1); and three species from the sub-antarctic islands described by myself (2, 4) as new. From Australia, in addition to two introduced species, Michaelsen (12) has described two species from south-west Australia.

Of the family *Tubificidae*, two species were described by me from the lakes of New Zealand (1) and two from the subantarctic islands (4), while one species described by me as new is identified by Michaelsen as being in reality an introduced European form. From Australia one species of *Clitellio* has been recorded by Michaelsen (12), while I described two species (a *Tubifex* and a *Branchiura*) from Mount Kosciusko (3). We are thus in need of very much further work on these smaller worms before they can be employed as evidence for geographical purposes. So far as is known, however, the "home" of the *Enchytraeidae* is, like that of the *Lumbricidae*, the Northern Hemisphere; and though I describe these as new species I am quite prepared to admit that they may have been introduced into the Kermadecs.

Since it is known that a single cocoon formed by such a worm as an Enchytraeid may contain several eggs or embryos, the arrival of such a cocoon, by whatever means it may be transported, in an island such as Sunday Island is sufficient to start a new colony of that species. For instance, Michaelsen (9, p. 11) records for *Lumbricillus maximus* that in one cocoon he opened there were as many as 33 eggs; in others, from 20 to 30 embryos.

Fam. Enchytraeidae.

Fredericia bollonsi sp. n.

Three well-preserved specimens were received from Captain Bollons in 1904, without any definite information as to the conditions under which they were collected. One of these was stained and mounted as an entire object, and later cut into sagittal sections; another was similarly studied, and then cut into a series of transverse sections.

Fig. 1.—*F. bollonsi*. A chaeta.

As the specimens are all more or less curved or curled, it is only possible to give approximate measurements; they measure from about 12 mm. to 16 mm., and in a shorter one I counted 56 segments.

The chaetae are two in each of the dorsal and ventral bundles, and this number is retained throughout the worm; only here and there in a very

* These numbers refer to the list of works given in the bibliography at the end of the paper.

few segments was a third chaeta present in a bundle. The chaetae are straight and of equal lengths.

The clitellum covers segments xii and xiii, and about half xi.

The head pore lies between the prostomium and peristomium; the first dorsal pore occurs in segment vii. These dorsal pores, as Eisen has pointed out in his account of some American species of the genus, do not lie in the intersegmental furrows, but at a little distance from the anterior septum of the segments, at about one-quarter the distance between the two septa.

The brain is convex posteriorly.

The pharynx lies in segment iii, and has the usual bisymmetrical, non-ciliated pad of long columnar cells on its dorsal wall, through which the ducts of the septal glands open.

The oesophagus passes through the following segments as a straight narrow tube lined with low ciliated cells, outside which is a rich vascular plexus. In segment xiv the gut enlarges, and this enlarged region, which traverses segments xiv, xv, and xvi, is constricted at the septa. In these segments the epithelial cells assume a very characteristic form and arrangement, which has been utilized by Eisen (7) as one of the diagnostic features of the genus. The cells are very tall, and bear long cilia, and amongst them, as that author has shown in a series of beautiful drawings, are found other cells, each of which is hollowed out by a canalicule which at its base curves at right angles to the axis of the cell. These cells, which were studied years ago by Michaelsen, who termed them "chylus cells," are not all of the same height, so that the surface of the epithelium is very irregular.

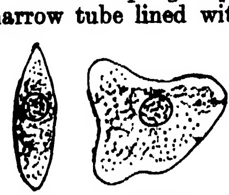


Fig. 2.—*F. bolloni.*

A coelomic corpuscle, seen edgewise and in face (from camera outline).

In segment xvii this region of the chylus cells passes into the ordinary intestine, in the cavity of which dirt accumulates. The epithelium is lower, the cells being only about one-quarter the height of those in the preceding region, and the cilia shorter. There are here no chylus cells.

The dorsal vessel becomes evident at about the 20th segment: in one case I noted it in the 19th; in another in the 21st. I did not attempt to trace out the vascular system.

Septal glands lie in segments iv, v, and vi.

There is on each side a simple peptonephridium, lying below the oesophagus in segments iii to vi; at its hinder end it branches or rather bifurcates, one branch being narrow and short.

The nephridia have a large ante-septal region, consisting of the usual mass of connective tissue traversed by a fine canal which winds about therein. After passing through the septum it enters and traverses the post-septal region, which is distinctly less in extent than the ante-septal. It is difficult to trace out the details or to reconstruct the outlines from the study of sections, but in the series of transverse sections I counted 13 sections through the ante-septal and 9 sections through the post-septal regions respectively. The duct leaves the latter near its commencement, close behind the septum.

The Genital Apparatus.—The testes are lobulated. The sperm-funnel has the usual massive form; it is apparently somewhat pyriform in shape, though it is abruptly bent on itself, and it appears to be rather broader than long, unless it has shrunk unequally. This region is made up of

glandular cells radiating from the narrow sperm-duct which traverses it in an eccentric course, for in sections, both longitudinal and transverse, it is seen to lie nearer the mesial than the lateral, nearer the ventral than the dorsal surface. At its anterior free end the gland carries a plate of low ciliated cells, which surrounds the entrance to the duct—the true "funnel." This plate has only a slight elevation above the gland-cells. After leaving the funnel the sperm-duct passes through the septum as a narrow tube which is fairly convoluted before it enters and traverses the glandular "prostate." The prostate, or "atrium" as it is usually termed, is a hemispherical mass of gland-cells surrounded by a thin sheath of muscle, and resembles the organ figured by Eisen for several of the American species. The male pore, situated in segment xii, in line with the ventral chaetae, which, of course, are absent in this segment, lies in a slight depression of the surface, surrounded by a distinct folded lip, as seen in the entire worm.

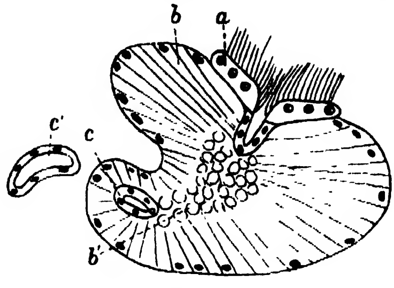


FIG. 3.—*F. bollonsi.* Longitudinal section through the sperm-funnel. *a*, ciliated cells; *b*, glandular (prostate) cells; *b'*, the same cut transversely and obliquely; *c*, portion of the sperm-duct traversing the glandular region; *c'*, the same outside.

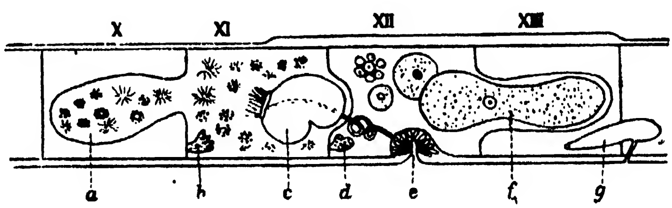


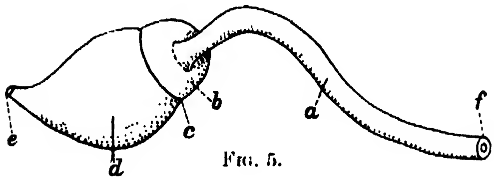
FIG. 4.—*F. bollonsi.* Diagrammatic reconstruction of the reproductive organs in side view. The extent of the clitellum is indicated by the thicker body-wall dorsally; the segments are numbered. *a*, sperm-sac; *b*, testis; *c*, funnel of the sperm-duct; *d*, ovary; *e*, atrium and male pore; *f*, ovum in ovisac; *g*, nephridium.

This is but a single sperm-sac, which occupies segment x, and communicates with segment xi, itself filled with developing spermatozoa. There is no posterior sac.

The egg-sac contains a large ovum, lying in segments xii, xiii, pushing the septum backwards so that it rests against the hinder end of xiii. Other eggs of less size lie free in xii, and the ovary has the usual position on the anterior septum of this segment.

The spermatheca is a nearly spherical but somewhat pyriform sac, which communicates with the oesophagus at the hinder end of segment v by a narrow duct. The wall of the "ampulla" is differentiated by the character of its epithelium into two moieties—that moiety nearer the oesophagus is lined by gland-cells which are of small height over about half the circumference of the ampulla, as seen in longitudinal section; but at about the equator the cells rather suddenly increase in height, forming a ring-shaped diaphragm projecting into the cavity. Below this, nearer

the exit of the duct to the exterior, the epithelium again becomes low, and the cells have lost the glandular character. It is in this moiety that the spermatozoa are found; it corresponds to the diverticula, which in most species of *Fredericia* form prominent outgrowths round the exit of the duct; but in this species, as in a few others, this "storage-chamber" does



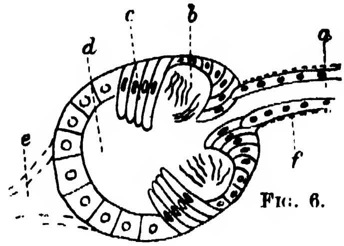


FIG. 5.—*F. bollonsi.* A spermatheca, drawn from a cleared specimen. *a*, duct; *b*, sperm-reservoir; *c*, furrow; *d*, ampulla; *e*, opening into the oesophagus; *f*, opening to the exterior.

FIG. 6.—*F. bollonsi.* Longitudinal section through the spermatheca, but not in its median plane. *a*, duct; *b*, sperm-reservoir; *c*, "diaphragm-cells"; *d*, ampulla; *e*, the dotted lines indicate the position of the oesophageal communication, which is present in the neighbouring sections; *f*, circular muscles of duct. The position of the nuclei in the cells is diagrammatic.

not project beyond the outline of the ampulla. As seen in transverse section it is single, it is not a double rudiment; it surrounds the ampulla continuously, and in the entire specimen it can be seen, too, to be separated from the ampulla by only a slight constriction, which I did not observe in the sections.

The duct of the spermatheca takes its origin at the apex of a conical group of cells which project far into the cavity of the ampulla; hence in longitudinal sections the cavity is divided into three chambers—a pair of smaller and one median larger, the "pair" being really continuous round the circumference.

The duct, after leaving the ampulla, remains as a narrow tube, which passes obliquely downwards and forwards to its pore at the anterior end of segment v; here it opens directly to the exterior without any glandular annexe. The wall of the duct consists of an epithelium surrounded by a coat of muscle. The duct is about twice the length of the ampulla.

Remarks.—So far as my acquaintance with the literature enables me to compare this worm with those previously described, it must be regarded as new, for amongst those species of the genus in which the spermatheca is without diverticula, as enumerated by Michaelsen (10), Eisen (7), Bretscher (6), and others, I find none that agrees in all points with the present one.

From a superficial examination it seemed likely that it would fall into the species *F. bisetosa* Levinsen, with which it agrees in the limited number of chaetae per bundle, and in one or two other features; but, as Michaelsen states that the spermathecae are provided with "*zwei sich gegenuberstehenden, kugeligen frei abstehenden Divertikeln,*" it is impossible to bring it within that species; moreover, it disagrees on other grounds.

All the species hitherto described in which the diverticula are absent differ from the present in one or more other characters, such as the number of chaetae in the bundle, the presence of glands at the external opening

of the spermathecal duct, the distribution of the chylus cells, relative size of ante- and post-septal portions of nephridium, and so forth.

The species without diverticula to the spermathecal ampulla are: *F alba* Moore, *F. bulbosa* Rosa, *F. striata* Levinsen, *F. harrimani* Eisen, *F johnsoni* Eisen, *F. fuchsi* Eisen, and *F. sonorae* Eisen. All these have more than 2 chaetae in each bundle. *F. alba* has, moreover, the first dorsal pore on segment vi, instead of in the usual segment vii; *F. bulbosa* has generally 4 chaetae per bundle, though this number is reduced to 2 in the posterior segments.

Hence the present worm does not fall into any of the above species; but how far the number of chaetae may be relied on as diagnostic when certain other structures agree in two species I do not attempt to decide (see below); there may be a certain range of variation, and it is also to be noted that in *F. bulbosa* glands may (according to Ude and Moore) or may not (*fide* Rosa) be present at the exit of the spermatheca.

The species in which the number of chaetae is limited to 2 per bundle are: *F. bisetosa* Levinsen, *F. leydigi* Veydovsky, *F. oligosetosa* Nusbaum, *F. monopera* de Martiis, *F. diachaeta* Bretscher, and F. *clitellaris* Bretscher; but each of these differs from the species under discussion in various other anatomical features.

As to the extent of the chylus cells, it is only by Eisen that this is used as one of the specific characters.

The majority of the species of Enchytraeids has, it seems, only been studied in the fresh state on the entire or dissected specimens, hence such a matter has been overlooked; moreover, it is only of recent years that these chylus cells have been investigated outside one or two common European species. Certain features can only be properly and accurately noted in fresh specimens which can be teased out: such things as the relative lengths of the spermathecal duct, the funnel of the sperm-duct, the exact form of the nephridium—these cannot be well noted in sectionized worms. It thus comes about that when one is limited to preserved material it is difficult to compare one's observations with those recorded by other observers who had fresh and perhaps an abundant supply of such worms; and it is therefore with some hesitation that I bestow a new name on this worm, for I feel that it is by no means unlikely that it is already known, for Michaelsen (9, p. 19) writes of a species found at St. Paul and New Amsterdam in the Subantarctic region: "Whether this *Fredericia* is *F. bisetosa* or some other species doubtless it has been introduced into these islands of the Southern Hemisphere. The 'home' of *Fredericia* is the north temperate region. The species of *Fredericia* of the Southern Hemisphere are, so far as can be decided, all wanderers."

The only species of the genus that has been recorded from New Zealand is a widely distributed form—*F. galba* (or *F. antarctica* of Beddard), from which the present one differs in several respects.

Fredericia bollonsi var. oliveri.

A collection of five specimens of this variety was forwarded to me by Mr. W. R. B. Oliver with the other material. They were found "under nikau-palm leaves, on damp ground, on the terraces, Sunday Island, July, 1908."

They measure from 10 mm. to 15 mm. in length, and have from 48 to 50 segments. From a study of entire specimens I supposed that this was a different species from the above, but after examination of sections, both

transverse and longitudinal, I can find no difference from it except in the chaetal formula.

The chaetae are straight rods, arranged in a fan-shaped manner; the dorsal bundles contain usually 6 anteriorly to the clitellum, and 4–6 posteriorly. The ventrals have 6 or 7 anteriorly, and posteriorly may have but 4, though usually the number is greater. The number in both bundles occasionally drops to 3 in some of the segments. The chaetae are not all alike in length, those in the middle being shorter than those on the outside.

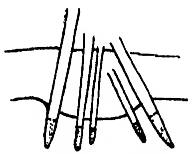


Fig. 7.—*F. bollonsi* var. *oliveri*. A group of lateral chaetae from the 10th segment (camera); the tips are restored.

All the specimens collected by Captain Bollons agreed in having, practically throughout the body, only 2 chaetae; all these in Oliver's collection have the above arrangement. Had I found the numbers mixed in the two lots, there would be no doubt as to the validity of placing them in one and the same species; but I am faced with a doubt as to whether this marked difference in the chaetal formula warrants one in forming even a new variety, for it does not appear that any study has been made as to the extent to which variation in this feature may go. Usually the number of chaetae forms one of the diagnostic features; but it seems to me preferable to make this a variety under the circumstances of their collection.

Fam. Tubificidae.

Rhizodrilus kermadecensis sp. nov.

Four specimens were found in a "waterhole, on Meyer Island, 24/4/08." They are a good deal curled and twisted, so that it is difficult to give actual measurements, but approximately they would, I think, be about 40 mm. in length.

The prostomium is somewhat bluntly pointed—a rounded cone.

The chaetae are all alike, bifurcated hooks similar to those of Tubificids generally. The upper or distal prong is longer and slenderer than the lower prong, which is about twice its thickness.

Fig. 8.—*R. kermadecensis*. The free end of the chaeta.

In the dorsal bundle there are 5 or 6 in the ante-clitellar segments and 2 in the rest of the body. The ventral bundles contain 4–6 in the ante-clitellar segments and 3–2 posteriorly.

The clitellum occupies segments ½x, xi, xii, and ½xiii—that is to say, that in the case of the first and last the glandular thickening ceases at the level of the chaetal ring.

The male genital pore is median, in segment xi; as is also that of the spermatheca, in x. The pore in each case is longitudinal, with somewhat overhanging lateral lips. These are especially noticeable in the case of the male pore.

The Male Apparatus (fig. 9).—The testes occupy the usual position.

The sperm-funnel is very wide, flattened, and lies in the hinder wall of segment x. From it issues the sperm-duct, which takes a nearly straight course to the hinder end of segment xi. This first portion of the duct is clothed with a continuous covering of tall club-shaped coelomic epithelial

cells, which constitute a diffuse "prostate," as in other species of the genus. When it enters segment xi it lies low down, close to the nerve-cord; but it gradually passes outwards and upwards to lie at the side of the oesophagus at about the middle of the segment. It continues to rise till at the hinder end it is on the level of the roof of the oesophagus, or even higher. At this point the prostate cells cease, the sperm-duct bends abruptly downwards, and passes somewhat forwards and outwards to open into a suddenly enlarged terminal "atrium," or "penial sac" as Moore (13) calls it.* The atrium, in its turn, communicates with the posterior extremity of the invaginated body-wall, which encloses a chamber to which Goodrich has given the name "spermiducal chamber," a median structure which opens by a longitudinal slit-like aperture to the exterior.

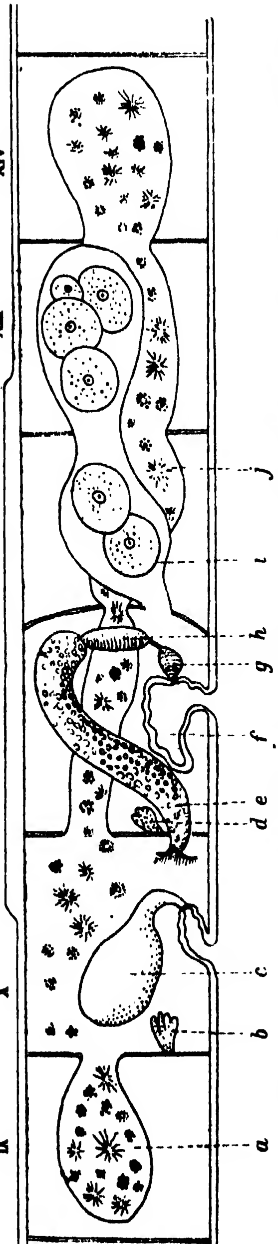


FIG. 9.—*R. kermadecensis*. A diagrammatic reconstruction of the reproductive organs in side view. The proportions are not accurate. The segments are numbered. The extent of the clitellum is indicated by the thicker region of the body-wall dorsally. *a*, anterior sperm-sac; *b*, testis; *c*, spermatheca; *d*, ovary; *e*, prostatic covering of sperm-duct; *f*, spermiducal chamber; *g*, muscular duct with wide lumen or "atrium"; *h*, transverse duct with narrow lumen; *i*, ovisac; *j*, posterior sperm-sac.

The sperm-duct, from funnel to its opening into the atrium, is lined with ciliated epithelium, outside which is a layer of circular muscles, as Goodrich has figured. At its entrance into the atrium the duct traverses a group of large (? gland) cells which project into the wide lumen of the atrium, the wall of which is muscular. The anatomical relations suggest that this region is eversible, or is a part of the "chamber": the muscular duct would then act as a "ductus ejaculatorius."

In some species of the genus this region has rather tall gland-cells forming the epithelium, but in the present case the cells are low, and not apparently glandular. However, it may be that in certain phases of sexual maturity they do become higher, and take on a definitely glandular structure.

The "spermiducal chamber" (or "atrium" as Moore, unfortunately, calls it) is a hemispherical sac projecting into the cavity of the segment, occupying nearly half its extent. It is, as Goodrich (8) has shown, merely

* It seems to me that this region corresponds to what is usually called "atrium" in the other Tubificids; the term "penial sac" is used in another sense.

a depression of the body-wall, formed during the growth of the worm. It is very muscular, and is provided with muscles which connect it with the body-wall. It receives the two spermducts on its posterior face, close on each side to the nerve-cord.

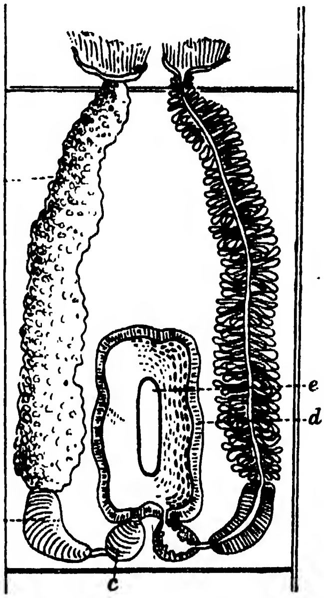


FIG. 10.—*R. kermadecensis.* Plan of the male ducts, supposed to be seen from above with the roof of the spermiducal chamber removed. The proportions are not accurate. The organs on the right side are shown in section. *a*, prostate; *b*, transverse duct; *c*, atrium; *d*, cut wall of spermiducal chamber; *e*, its external opening.

Segment x is filled with developing spermatozoa; and there are two median sperm-sacs—an anterior sac, which passes into segment ix, communicating with segment x around the dorsal vessel; and a posterior sperm-sac entering segment xii, and, in another individual, into segment xiv, and lying below the ovisac, from which, however, it is quite distinct; it does not project into it, as it does in *R. pilosus*, for instance.

The ovary has the normal position attached above the sperm-duct, and there is a large ovisac occupying segment xii, in which are 2 large ova, filled with yolk-spherules. In the individual cut transversely, the sac extends into at least the 13th segment.

The spermatheca is paired in segment x; each is a large ovoidal sac, from which the duct is not distinctly marked off from the ampulla externally. The ampulla lies obliquely across the segment, and reaches from near the lateral to the median line. The duct is indicated in section by the glandular and muscular thickening of the wall; its diameter decreases gradually till it is very slender, where it enters the body-wall. The right and left spermathecae open into a shallow, wide, median depression corresponding to the median spermiducal chamber.

In the individual sectionized sagittally, I find that the duct of each spermatheca crosses over the median line below the nerve-cord to open externally on the opposite side of the body.

Other Viscera.—There is a complex system of capillary blood-vessels on the inner surface of the body-wall, as has been described for other species. The dorsal vessel lies laterally on the right side in the genital segments. I noted the peculiar unicellular valves in the main vessels, as described originally by Goodrich.

The pharynx is surrounded by glands which fill segments iii, iv, and v, and the necks of these can be traced through the dorsal ciliated pad on the roof of the pharynx to open into its cavity.

I have found it impossible to make out details of the nephridial structure, but it recalls a Tubificid rather than an Enchytraeid organ. The canal coils loosely, and is surrounded by enlarged coelomic epithelial cells.

In the body-cavity I noted a good number of round granular vacuolate cells, the coelomic corpuscles, which in some segments, as in those immedi-

ately behind the pharynx, are so densely massed as to look like a gland; but they occur less packed elsewhere.*

Remarks.—There is still some doubt whether the genus *Monopylephorus* of Levinsen is or is not identical with *Rhizodrilus* of Smith (14), as I have pointed out in my account of *R. aucklandicus* (4. p. 260). Although Moore (13) retains the former title, I still prefer to use the name *Rhizodrilus*, associated as it is with the careful illustrated articles by Smith and Goodrich. Seven species of the genus have been described, the description of one of which (*R. fluviatilis* of Ferronnière) I have not seen.

The only species to which the present one exhibits close resemblances are *R. pilosus* Goodrich and *R. (M.) glaber* Moore.

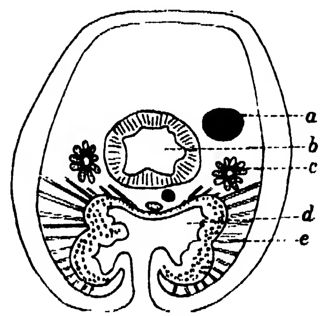


FIG. 11.—*R. kermadecensis*. Transverse section (camera outline) through the body in the region of the male pore. *a*, dorsal blood-vessel; *b*, oesophagus; *c*, sperm-duct with prostate; *d*, spermiducal chamber (the dots in its wall indicate the circular muscles); *e*, radial muscles to body-wall. The ventral blood-vessel is in black, and the nerve-cord is dotted.

With *R. glaber* the Kermadec worm agrees, and therein differs from *R. pilosus* in the following: (1) The arrangement of the chaetae, their number and structure; (2) in the arrangement of the sperm-sacs, especially in that the posterior sac does not enter the ovisac. On the other hand, the form and structure of the spermiducal apparatus is distinctly more like that in *R. pilosus*—namely, in the proportion of the post-prostatic region, in the relative size of the transverse duct, and other details. But in the present species the prostatic region is more extensive, and the muscular prostatic portion is shorter and takes a definitely transverse course, with a distinct enlarged atrium and without the sigmoid undulations shown in Goodrich's figure.

It seems, therefore, to deserve recognition as a distinct species. At the same time, one has to bear in mind that the two methods of study—that by sections and that by examining and dissecting fresh specimens—may account for some of the differences. For instance, while it is comparatively easy to dissect out in a fresh specimen the complete sperm apparatus, and thus determine accurately the proportions of the various regions, it is next to impossible to determine these proportions by means of sections unless one makes models of the sections and then reconstitutes the organ in an enlarged condition—a matter for which I have not sufficient time.

Again, whereas Goodrich was working on the worm from a more or less morphological point of view, and therefore failed perhaps to pay particular attention to such things as the exact number of chaetae per bundle—as

* In these sections I find that the intestine, posterior to the sperm-sacs, is filled with developing spermatozoa. I see no evidence of injury during sectionization, such as the dragging of the cells by the razor, to account for their presence here; but, as the worm is bent in this region, it may be that they entered as a consequence of injury to the gut owing to a strong contraction on being killed.

one may judge from the wording of his statement with regard to them—later authors having his memoir before them are concerned rather with systematic aspect of their worms, and are on the lookout for points of difference. It may therefore turn out that the present species is identical with Goodrich's, but it must, on the evidence before us, be regarded as distinct.

Fam. Lumbricidae.

Eisenia foetida Savigny.

Two specimens found "under leaves, &c., forest terrace, Sunday Island." This worm, which is about 2½–3½ in. in length, is familiar to people in New Zealand, where it is fairly common in manure-heaps and accumulations of rotting and fermenting vegetable matter. Its red body is marked with a yellow band round each ring, which band, however, does not completely encircle the body.

The species, like the following members of this family, is a native of Europe, North America, and Asia, but it has been carried by man in his agricultural and commercial intercourse into nearly every part of the world, so that it is now almost cosmopolitan.

These northern worms are evidently capable of existing wherever climatic conditions are suitable, and they can adapt themselves to new conditions readily. Wherever cultivation of the soil has been carried on, there one finds sooner or later these "introduced" earthworms supplanting those native to the country.

Helodrilus (Allolobophora) caliginosus Savigny.

This is an extremely variable species, as all authors who have studied the European worms have pointed out, from Hoffmeister (1845) to Michaelsen (1900). The variation affects the size and coloration chiefly, and it is probably associated in some way with differences in habitat and mode of life. So great is this variability that one can at first scarcely suppose them to belong to the same species till the anatomical features are examined; but in these features there is a fair amount of constancy, accompanied, however, by small variations in such matters as the extent of the clitellum.

In this collection we have two very marked variations: (A) A larger very dark-grey form, possibly with a bluish tinge when alive, attaining a length of 3–4 in.; and (B) a smaller and slenderer form, pale-coloured, flesh-tinted or pinkish in life, attaining a length of 2½–3½ in.

Variety A.—Four very dark-coloured worms, anteriorly brownish-grey; the clitellum paler brown. Length, 75 mm. by 5 mm., with 167 segments. These were found "under dead leaves, forest terrace, Sunday Island," July, 1908. Oliver's number, 25.

Variety B.—This is numbered by Oliver 14, and it is said to be "abundant in top soil, Denham Bay." They are in the preserved condition pale, almost colourless, apparently flesh-coloured in life, with a pale-brown clitellum. They measure about 50–70 mm., with a diameter of 2–3 mm.

Hab.—(*a.*) In the soil, Denham Bay (8/3/08), 32 individuals, mostly immature. (*b.*) "Under leaves, forest terrace, Sunday Island"; one immature individual. (*c.*) "Under nikau-palm leaves," Expedition Hill (16/10/08). Number, 29. Two specimens, mature.

Helodrilus (Bimastus) constrictus Rosa.

This is a worm of small size, about 1 in. in length. Pinkish in life. "Common everywhere—in forest, on damp ground; under dead nikau-palm leaves and tree-fern fronds." It is numbered by Oliver 29.

Hab.—(*a.*) "Under dead nikau-palm leaves," Exhibition Hill (16/10/08). Number, 29. There are fourteen specimens, all under 25 mm. in length, with the clitellum about midway along the body. Many are immature. (*b.*) "From rotten food, Denham Bay" (17/6/08). Eight immature forms, from 6 mm. to 16 mm. (*c.*) "Under leaves, forest terrace" (1/7/08). Numbered 3 in Oliver's list of stations or gatherings. Twenty-two specimens, some of which are immature, from 12 mm. to 30 mm. in length. (*d.*) "Under leaves, Denham Bay" (13/6/08)." Number, 20. Colour pinkish. Three specimens immature.

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ART. XXIII.—*A Remarkable Case of Bifurcation in* Lumbricus rubellus.

By W. B. BENHAM, D.Sc., F.R.S.

[*Read before the Otago Institute, 1st December, 1914.*]

1. EARLY in the present year I received from Mr. James Jefferys a specimen of *Lumbricus rubellus* (an introduced European earthworm) which bears on its right side a short narrow branch or outgrowth.

The worm is adult, in that the clitellum is well developed, and the peculiarity about this particular example of what is not a very rare occurrence is that the branch is developed in this clitellar region. This anterior situation of the bifurcation is, so far as I can gather, unique, as it is usually much farther back.

The clitellum commences on the 27th segment, and occupies seven segments. The first of these segments is distinct from the 2nd over the

ventral surface and on the right side, but on the dorsal surface and on the left side it is merged into the 2nd. The 3rd segment as seen from above is unsymmetrical, but owing to a wound in the skin on the dorsal surface the exact course of the intersegmental furrow cannot be traced. It is from the hinder face of this segment that the branch arises, on the right side and nearer to the dorsal than the ventral surface. As seen from below, this segment has the form usually seen in bifurcated worms—that is, its posterior boundary on the right side is oblique, forming an angle of nearly 45° with the long axis of the body. Consequently a backwardly directed

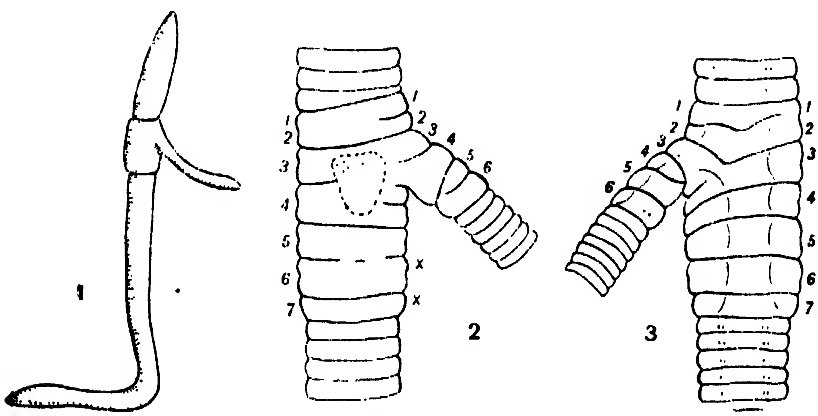

FIG. 1.—Outline of *Lumbricus rubellus*, with a branch on its right side springing from the clitellum. Natural size.
FIG. 2.—Dorsal view of the clitellar region: the dotted area represents a damaged portion of the skin. × 4.
FIG. 3.—Ventral view of the same. × 4.

angular projection exists between the branch and the body. This angle, or "axilla," is clearly seen ventrally, but is merged into the next segment on the dorsal surface.

The 4th segment of the clitellum, again, is unsymmetrical, as seen from above, being wider on the left and narrow on the right side, just below the axilla.

The remaining segments, 5, 6, and 7, are normal. It is usually the case in these bifurcated worms that some segments are abnormally and irregularly developed.

Traces of the tubercula pubertatis are present in the form of a slight ridge on each side of the 3rd, 4th, 5th, and 6th segments, at the line where the glandular epidermis ceases latero-ventrally.

The branch thus springs from the 3rd clitellar segment; and the following three segments that form its base are also glandular—that is to say, the clitellum is continued on to the branch, and the ridge (or tubercula pubertatis) is continued along the outer side of these three segments.

The body is 73 mm. in length, with a diameter of about 4 mm. just behind the clitellum; the branch measures 14 mm. by 1·75 mm., and arises, as the figure shows, at a point about 18 mm. from the anterior end. It contains 15 segments, mostly biannulate, as on the body of the worm.

The chaetae on the body are, of course, in four couples, the individuals of a couple being close together; but the only chaetae that I can detect

on the branch occur on the inner side of the 3rd segment (corresponding to the 6th clitellar segment). Possibly they are also present on the preceding segments, embedded in the skin ; but there are none on the rest of the branch.

At the end of the branch is a slight pit, which suggests that an anus is present here ; it is, however, imperforate ; and on opening the branch at two places I find that the intestine does not enter it, but the nerve-cord and the nephridia are continued to the end of it.

It is, of course, difficult, if not impossible, to say how this bifurcation or branching has come about in the free state. It may be that the worm was injured at the commencement of the clitellar region, and that a lateral outgrowth developed instead of a mere healing of that wound.

The specimen is remarkable not only on account of the forward situation of the bifurcation, but also on account of the great inequality in size between the two forks, and finally on account of the absence of the intestine in the smaller branch.

II. In 1886 Mr. T. W. Kirk described and figured a "Curious Double Worm."* This specimen remained in the Dominion Museum till about two years ago, when the late Director, Mr. A. Hamilton, was good enough to send it to me for examination. When it reached me it was glued to a piece of card. It was evident that at some time it had become dry, owing to the evaporation of the alcohol, for the tails are shrunken and the skin a good deal shrivelled. However, it is in sufficiently fair preservation for me to add something to Mr. Kirk's account.

A re-examination of this specimen seemed desirable, for Mr. Kirk was one of the first to place on record the occurrence of a bifurcated worm, the only previous accounts being those of Asa Fitch in America in 1865 (in a report on insects in the State of New York), C. Robertson in England in 1867, and Bell in 1885.. It is evident that Kirk did not know of either of these. A fair number of similar cases have been recorded since that time, but Kirk's paper has been overlooked by all these writers, even by the most recent, Korschelt (1914).

The worm is a species of the genus *Octochaetus*, though, as it is immature, it is impossible to define its specific position. Kirk recognized that it was not a Lumbricid, but a native, though he figures the prostomium as being like that of *Lumbricus*—"tanylobic," whereas it is "epilobic," without the prolongation into the 1st segment. The chaetae are all on the ventral surface, small in size and close together, so close that each couple looks at first like a single bristle. The lines are approximately equidistant, though the two ventral rows are rather farther apart than the lateral row is from the ventral of its own side.

Kirk's measurements may be given in his own words : "The anterior portion is about 1 in. in length and ¼ in. in diameter. . . . From the posterior end of the thick part, which terminates abruptly, spring two limbs, each 2½ in. in length and of an average diameter of ⅛ in."

At present the "body" measures 14 mm. in length by 6 mm. in diameter ; the two "tails" are unequal, one measuring 33 mm., the other 40 mm., each with a diameter of about 2·5 mm. These two tails are curved and undulating, a good deal shrunken, and one came away from the body on the specimen being removed from the card.

* Trans. N.Z. Inst., vol. 19, p. 64.

The "body" contains about 40 segments, biannulated, and much compressed. I did not count the segments in the tails, but they are very much more numerous, and are about the length of one annulus, and are uni-annulated. The two tails are symmetrically placed, as Kirk's figures show, and are separated by a narrow area at the hinder end of the body. The two rows of chaetae of the right and the two rows of the left side are continued on to the two tails respectively; while on the inner side of each tail two additional rows of chaetae make their appearance, though exactly at what point they commence it is impossible now to say, owing to injuries at their bases.

Kirk states that "the anal aperture is situated immediately at the posterior end of the thick portion, and between these two limbs or tails." I am unable to confirm or to refute this statement, though from analogy with other cases I doubt whether it is the case here. At any rate, I must correct the statement that follows: "There is no aperture in the end of either limb, though there is a spot which at first sight gives the impression that an opening is present." In this instance "first thoughts" would have been best, for there is an actual perforation at each end, and an incision into the tail shows that the intestine is continued into it. This is quite what is to be expected, for in all cases which have been dissected, as Robertson was the first to show, the internal organs are, like the body-wall, bifurcated.

In short, this specimen is very similar to most of those that have been described, except that the body is much shorter than the tails, for generally the bifurcation occurs nearer to the hinder end.

Korschelt has suggested that in these cases, with approximately equal tails, the bifurcation is due to an embryonic process—a kind of twinning. He refers to a young individual of *Allolobophora subrubicunda*, which he removed from the cocoon, being bifurcated, and was therefore not the result of injury, but was probably due to the partial division of the ovum or embryo. It is known that in some species of *Lumbricus* the ovum does divide into two embryos at an early stage of its history; in these instances of bifurcation, then, the division has been incomplete.

III. Mr. T. W. Kirk was good enough to send me a water-coloured drawing of a living bifid worm with two approximately equal "tails" and very similar to that described by Robertson, Bell, Williamson, and others. Unfortunately, it has not been identified, but it looks to me like *L. rubellus*. It was found in Rangitikei.

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Art. XXIV.—*On* Lumbricillus macquariensis *Benham*.

By W. B. Benham, D.Sc., F.R.S.

[*Read before the Otago Institute, 1st December, 1914.*]

In 1904 I described a species of Enchytraeid from the Macquarie Islands under the name of *Lumbricillus macquariensis* (1, p. 295). Later, in 1909, I gave an account of a worm from the Campbell and Auckland Islands, to which I gave the name *L. intermedius* (2, p. 261). Recently I have received from Mr. Harold Hamilton additional specimens from the Macquaries, where he was collecting during his stay there as a member of the Mawson Antarctic Expedition; and I have been entrusted with the large series of Annelids, both marine and terrestrial, which was collected by that expedition. While studying the Enchytraeids I was led to re-examine my preparations of the specimens received at the earlier dates, and have arrived at the conclusion that the species "*L. intermedius*" is identical with *L. macquariensis*.

A comparison of the two accounts shows that the points of difference affect the following organs: (*a*) The nature of the spermathecal opening into the oesophagus; (*b*) the number of chaetae in each bundle; (*c*) the segment in which the dorsal vessel becomes free from the intestinal blood sinus; (*d*) the number of the subneural copulatory glands; (*e*) the size and proportions of the spermiducal funnel.

A. The re-examination of the type of *L. macquariensis*, and of sections made of other specimens received at that time, shows that I made an error in affirming and figuring the existence of "a narrow duct" putting the spermatheca into communication with the oesophagus. And to this error I added some confusion in a note at the end of my account of "*L. intermedius*" by stating (p. 261), "It is quite distinct from *L. macquariensis*, which belongs to another group of the genus in which the spermathecal duct is strongly marked off from the ampulla." The latter statement is clearly a *lapsus calami*, for what was intended is evidently a contrast with the "narrow communicating-duct," and not with the external opening.

But it is difficult now to understand how I came to make the original statement as to the existence of the "narrow communicating-duct." The series of transverse sections show quite distinctly that there is no such "duct"—the ampulla communicates with the oesophagus by a small pore due to the sudden contraction of the ampulla, as I have described and figured for "*L. intermedius*" (pl. x, fig. 8).

In order to convince myself further I opened a specimen from the same lot, and it is certain that no such "duct" exists. The mounted specimen which served as the type, when studied without the knowledge derived from the other studies, does suggest a short duct, as the spermatheca is bent at a point close to its entrance into the oesophagus; but with the other evidence before me I recognize that the statement was due to faulty observation. (It is worth noting that Michaelsen made a similar error in his first account of *L. maximus*.)

Having discovered this mistake I proceeded to examine each of the other characters more carefully.

B. As to the chaetae, I find from a study of eight individuals that there is a considerable range of variation, as may be seen by a study of the annexed table, in which I have summarized the number of chaetae in the dorsal and ventral bundles in the pre-clitellar and in the post-clitellar region of the body of specimens from the Macquaries and from the Campbell and Auckland Islands. It will be noted that the difference between extremes such as No. 2 and No. 5 amongst specimens from the Macquaries is greater than the difference between No. 2 and No. 8 from two distant islands, and it is impossible to include in the diagnosis of a species a character with such a wide margin of variation.

C. It will be noted, too, that the segment in which the dorsal vessel originates shows a similar variation. It is true that in the type it commences at the hinder end of the 13th or 14th segment, while in the type of "*intermedius*," as I can confirm from renewed examination, this point is in segment 17; but even amongst those from the Macquaries the position varies, being in two cases in the 15th, in a third in the 16th, while in one that was sectionized it lies in the 17th segment.

D. The number of the subneural glands, which are characteristic of this genus, exhibits the same instability, for though usually there are 3 glands in segments 14, 15, and 16, there is one individual from the Macquaries in which there are 6 glands, and in two "*intermedius*" there are 4.

E. Finally, I made a point of the proportion of length to breadth of the funnel of the sperm-duct, for in the type of *L. macquariensis* I stated that the length is twice the breadth, whereas in "*L. intermedius*" I gave it as about five times the breadth. I have measured it in three funnels of "*intermedius*" whose outlines I drew with the camera, two in a series of longitudinal sections, and one in a bisected specimen mounted as a transparent object. From these measurements I find that the length is respectively five, five and a half, and six times the breadth.

I am unable to give measurements for the funnel of *macquariensis*, as it is bent in all the preparations, but the proportions given in the original statement seem to be borne out. But the state of preservation of the type is bad; the worm was soft, and it is possible that the gland-cells around the funnel are much swollen, just as those of the subneural glands are. In my figure of the latter (1, pl. xiv, fig. 8) they are represented as much too broad and too high. Without at that time having well-hardened specimens for study, I did not recognize the effect of this bad preservation on the gland-cells; but a comparison of the sections with well-preserved material shows at once the fact that the gland-cells are swollen, so that the whole gland appears larger than it would be in life. Hence again the difference between the figure of *macquariensis* referred to and that given for "*intermedius*" (pl. x, fig. 9).

So I think we may take it that in the case of the funnel gland-cells the same explanation may be given: their swollen condition increases the width of the funnel, and led me to give proportions which are no doubt untrue in life. It is not improbable, however, that the size of the gland-cells in both glands may vary according to the sexual condition of the worm, and it is likely that when fully mature in the breeding season the glands would be larger. I conclude, then, as a result of this comparison, that

" *L. intermedius* " is synonymous with *L. macquariensis*, so that this species has a distribution over the three subantarctic islands. The figures of the spermatheca, subneural glands, and sperm-funnel as given for "*intermedius*" must replace those given in the article on *L. macquariensis*.

Moreover, it is, it seems to me, closely allied to *L. maximus* Michaelsen (3, p. 10), from which it differs in its smaller size, for that is stated to measure 40 mm. in length, whereas our species does not exceed 25 mm., and some of the mature individuals are less; and the variety of *L. maximus* termed "*robinsoni*" is but 12–16 mm. in length, but the clitellum is interrupted on the ventral surface.

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TABLE SHOWING THE NUMBERS OF CHAETAE, ETC.

	Chaetae.				Subneural Glands.	Origin of D. Vessel.
	Pre-clitellar.		Post-clitellar.			
	D.	V.	D.	V.		
1. *L. macquariensis* (type) ..	6 (5)	5 (4, 6)*a*	4 (5)	5	14, 15, 16	13 or 14
2. " (cotype) ..	6 (7)	6 (5)*b*	5 (4)	6 (5)	14, 15, 16	?
3. " (H. H.) ..	5 (6)	6 (5)*a*	4	5	14, 15, 16	16*c*
4. " (H. H.) ..	6 (7)	7 (6, 5)	?	?	*d*	15
5. " (H. H.) ..	4	5 (6)	3	4	14, 15, 16*d*	15
6. "*L. intermedius*" ..	5	6	4	5	14, 15, 16, 17	17
7. " ..	5	6 (7)	4	3 (4)	14, 15, 16	16
8. " ..	6 (5)	7	5 (4)	6 (5)	14, 15, 16, 17	?

NOTES TO THE TABLE.

The numbers enclosed in brackets occur less frequently along the body.

a. In one segment there are 7 chaetae.

b. There is considerable irregularity throughout the body in this individual, the number in each bundle often differing in successive segments, and on the two sides of the body; thus each of the segments ii and iii has 8 chaetae on one side and 6 on the other.

c. In one individual sectionized the dorsal vessel occurs in the 17th segment.

d. In one individual there are 6 glands in segments 13–18, the largest being in the 15th; but in two other specimens only 3 glands exist, but I did not correlate them with the chaetal formula.

? The fact was not observed in these specimens.

H. H. Specimens collected by Mr. H. Hamilton.

ART. XXV.—*Descriptions of New Species of* Lepidoptera.

By ALFRED PHILPOTT.

Communicated by Dr. W. B. Benham, F.R.S.

[*Read before the Otago Institute, 6th October, 1914.*]

CARADRINIDAE.

Aletia (?) lata sp. nov.

♂ ♀. 40–45 mm. Head and thorax brownish-grey, in ♀ more whitish. Antennae in ♂ (broken). Abdomen pale brownish-grey. Forewings *broad*, costa slightly arched at base, almost straight, apex rounded, termen evenly rounded, oblique; fuscous-grey, densely intermixed with white; lines black; an interrupted irregular basal line, margined outwardly with white; first line irregularly dentate, from ⅓ costa to ⅓ dorsum; *second line strongly dentate, margined outwardly with white, commencing at ½ and running obliquely beneath costa to about ⅞, thence strongly rounded to vein 2;* orbicular and claviform almost obsolete; reniform somewhat narrow, white-ringed, grey within, anteriorly margined with a suffused dark blotch; an obscure subterminal serrate whitish line; a similar terminal line: cilia grey. Hindwings fuscous-grey: cilia grey with whitish tips.

Apart from the broader forewings, the strongly dentate second line sufficiently distinguishes this species from the other grey *Aletias*.

Vanguard Peak, in January; a ♂ and ♀, taken by Messrs. H. Hamilton and F. S. Oliver, in the Dominion Museum collection. Bold Peak, in December; a ♀ taken by Mr. C. C. Fenwick. Types (♂ and ♀) in coll. Dominion Museum. The ♂ is in poor condition, and it is consequently difficult to pronounce with certainty as to the genus.

HYDRIOMENIDAE.

Chloroclystis luminosa sp. nov.

♂. 22 mm. Head and palpi dark green. Palpi 2. Antennae in ♂ ciliate-fasciculate, *ciliations* ⅓. Thorax dark green with some black and white markings posteriorly. Abdomen green with broad greenish-black antemedian band and median black dot on margin of each segment. Forewings triangular, costa slightly sinuate at middle, termen bowed, oblique; dark green; basal ⅜ dark greenish-fuscous with fasciae obscurely indicated; median band white with several waved green striae rather suffused and bluish except near costa, outer edge marked by prominent irregular black line broadly margined posteriorly with white; praesubterminal, costal, and supramedian blotches greenish-black; a suffused dark tornal blotch; subterminal line faint, waved, pale bluish-green; a black faintly waved line round termen: cilia grey-green with triangular fuscous bars. Hindwings grey, faintly greenish round dorsum and termen; numerous alternate light and dark striae; a dark discal dot; a blackish line round termen: cilia grey with obscure dark bars.

♀. 25 mm. As ♂, but median band wholly green except small white blotch in middle of disc, thus rendering the bluish-green striae very obscure.

From any other species of the group with fasciculate antennae in the ♂ the present from can be distinguished by the very short ciliations, these

being under 1. It is probable that when further examples are secured the white markings will be found to be subject to much variation.

Ben Lomond, in December. One of each sex at 2,000 ft., in bush.

Chloroclystis magnimaculata sp. nov.

♂ ♀. 19–21 mm. Head, palpi, and thorax greyish-green, in ♀ ochreous. Palpi 2. Antennae in ♂ ciliate-fasciculate, ciliations 4. Abdomen greenish-grey, in ♀ ochreous, with a reddish-fuscous antemedian band. Forewings triangular, costa gently arched, termen subsinuate, moderately oblique; greyish-green; costa narrowly reddish to ¼; numerous reddish-fuscous waved lines from base to ⅔, forming curved fascia at ⅛; outer edge of median band broadly and obtusely projecting at middle; *a large apical blotch of bright reddish-fuscous: a smaller and paler tornal blotch with a minute white dot near centre;* subterminal line serrate, grey-green; a reddish-fuscous line round termen: cilia greyish-green, suffused with reddish-fuscous except at middle of termen. Hindwings unevenly rounded; pale greenish-grey; a reddish-fuscous discal dot and numerous obscure waved reddish-fuscous striae, more prominent on dorsum: cilia greenish-grey with faint reddish-fuscous bars.

Nearest to *Chloroclystis maculata* Hdsn., from which it is easily known by the prominent apical blotch.

Queenstown, in November. I am indebted to Mr. M. O. Pasco for examples of this well-marked species.

Chloroclystis modesta sp. nov.

♂ ♀. 26–29 mm. Head, thorax, and abdomen dark brownish-fuscous, sparsely mixed with grey. Palpi reddish-tinged, 2½. Antennae in ♂ ciliate-fasciculate, ciliations 4½. Forewings rather narrow, costa subsinuate, slightly arched, termen sinuate on lower half, moderately oblique; *fuscous-brown;* markings obscure, grey-whitish; veins interruptedly marked with blackish; many irregularly serrate or waved transverse striae; a more distinct pair at ⅓, and 3 or 4 similar ones defining outer edge of median band at ⅔; an obscure blackish discal dot; a faintly greenish-tinged serrate subterminal line: cilia fuscous with paler median line, sometimes indistinctly barred with darker. Hindwings, *termen irregularly rounded, prominent at veins 3 and 4;* fuscous-grey, darker dorsally; a dark discal dot; some lighter striae obscurely indicated on dorsum: cilia as in forewings.

Differs from *Chloroclystis halianthes* Meyr. in the irregular termen of the hindwings. It is also much darker in colour, and the cilia are not distinctly barred.

Ben Lomond, in January, and Bold Peak, in December. Taken by Messrs. C. C. Fenwick and F. S. Oliver, at altitudes of from 3,000 ft. to 4,000 ft. Mr. Fenwick has kindly supplied me with material for the description of the species. Types (♂ and ♀) in coll. C. C. Fenwick.

Chloroclystis rubella sp. nov.

♂ ♀. 28–29 mm. Head, palpi, thorax, and abdomen dark greenish-fuscous with some admixture of greyish-pink and white scales. Palpi 2. Antennae in ♂ ciliate-fasciculate, ciliations 4. Forewings triangular, broad, costa in ♂ rather strongly arched on apical fourth, termen obliquely bowed; *dark greenish-fuscous mixed with black and tinted, especially round tornus, with pink;* veins interruptedly marked with black; lines very obscure;

a double, outwardly somewhat dentate, line at ¼; a hardly traceable similar basal line; median band moderate, inward margin curved, subdentate: outer margin irregular, followed by 4 or 5 alternate lighter and darker lines, most distinct on costal half; subterminal line bluish-green, serrate: cilia, basal half and suffused bars fuscous-greenish, apical half grey, flushed with pink. Hindwings, termen rounded; *fuscous grey, darker and flushed with pink towards dorsum and termen;* numerous obscure lighter and darker waved lines: cilia as in forewings.

Larger and darker than any other member of the section to which it belongs.

This species was also brought to light by Messrs. Fenwick and Oliver, they having secured several on Bold Peak, Humboldt Range, in December. Mr. M. O. Pasco has also taken it on Ben Lomond.

Xanthorhoe albalineata sp. nov.

♂. 26–30 mm. Head ochreous, face whitish. Palpi rather elongate, white. Antennae moderately bipectinated, stalk white basally. Thorax brownish-ochreous. Abdomen pale ochreous with paired linear black marks on the dorsal surface of each segment. Forewings triangular, elongate, costa slightly sinuate, hardly arched, apex obtuse, termen bowed, rather oblique; pale whitish-ochreous; markings greyish-fuscous; basal line obscurely indicated, angled above middle; first line from ¼ costa to ⅕ dorsum, irregular, sharply angled inwards above middle; a roundish discal dot; second line from ⅔ costa to ½ dorsum, bluntly projecting at middle, inwardly oblique at dorsum; median band slightly suffused with fuscous in disc and anteriorly to second line; an irregular patch of fuscous suffusion between upper third of second line and termen; a series of paired dots on termen, the apical ones tending to be inwardly produced as paired lines: cilia pale whitish-ochreous with a few dark scales opposite paired dots. Hindwings elongate, termen obliquely rounded; pale whitish-ochreous; a terminal series of paired fuscous dots: cilia pale whitish-ochreous. Undersides: Forewings ochreous, disc broadly fuscous; hindwings ochreous; *a straight white streak above middle from base to near termen, attenuated posteriorly, margined beneath with brownish-fuscous; a similar streak above dorsum.*

Nearest to *Xanthorhoe oraria* Philp., but distinguished from that species, as from all others of the genus, by the peculiar markings of the underside of the hindwings.

Stewart Island. Two males taken on the bare top of Table Hill (2,000 ft.), in December.

Xanthorhoe plumbea sp. nov.

♂. 18–20 mm. Head, palpi, and thorax grey mixed with black. Antennae fuscous, pectinations moderate. Abdomen grey, each segment bearing dorsally a pair of cuneate black marks. Forewings rather elongate, costa sinuate, moderately arched, apex subacute, termen almost straight, oblique; *bluish-grey with some reddish-ochreous on veins and posterior to second line;* lines formed of bluish-grey irregular paired striae; basal line obscure, curved; first line rather angulated at middle, margined anteriorly with white, angle marked with reddish-ochreous; a rather prominent spot of reddish-ochreous between basal and first lines at middle; a suffused reddish-ochreous discal spot; second line irregularly curved, its outer margin marked by a series of white points which are sometimes more or less connected by a thin white line; an obscure reddish-ochreous subterminal line; veins beyond second line marked with blackish interrupted by some

white dots ; an obscure black waved line round termen : cilia white, mixed with grey and with obscure darker bars. Hindwings rather elongate, termen strongly rounded ; fuscous-grey ; discal dot and some striae on terminal portion obscurely indicated ; an obscure waved black line round termen : cilia white, mixed with grey and with suffused darker bars.

The bluish ground-colour and longer antennal pectinations remove this species from *Xanthorhoe cineraria* Walk., which appears to be its nearest ally.

Queenstown, in November. Four specimens.

Xanthorhoe stricta sp. nov.

♂. 38–39 mm. Head, palpi, thorax, and abdomen pale greyish-ochreous. Antennal pectinations moderately long. Forewings triangular, costa almost straight, rather strongly arched apically, termen subsinuate, oblique ; pale greyish-ochreous ; markings fuscous-brown ; numerous thin waved more or less parallel transverse lines, forming more distinct bands near base, before middle, at $\frac{3}{4}$ and $\frac{7}{8}$; an obscure discal dot ; outer margin of third band sinuate inwards above and below middle ; an inwardly oblique thin subapical streak ; a terminal series of black dots, connected by a very faint waved line. Hindwings pale ochreous-grey with markings similar to forewings but suffused and obscure : cilia as in forewings.

In one specimen the ground-colour is darker and the lines very obscure, the approximation into bands being hardly noticeable.

Nearest to *Xanthorhoe cataphracta* Meyr., but distinguished from that species by the absence of the white fasciae and the somewhat longer antennal pectinations.

This and the following species, together with *Selidosema terrena*, *S. albafasciata*, and *Aletia lata*, were included in some moths submitted to me for identification by the Director of the Dominion Museum. Two males were taken on Bold Peak, Humboldt Range, in February, by Mr. W. G. Howes. Type (♂) in coll. Dominion Museum.

Dasyuris (?) fulminea sp. nov.

♂. 24 mm. Head black. Palpi densely haired, dark yellowish-brown. Antennae (broken). Thorax black with some yellow-brown scales. Abdomen black with yellow and grey scales, anal tuft yellowish. Forewings short, costa somewhat arched at base, very slightly deflexed at apex, termen rather strongly rounded ; deep blackish-fuscous finely irrorated with yellow ; fasciae pale yellowish-white (probably bright yellow in fresh specimens) ; basal fascia distinct, curved ; *first fascia from* $\frac{1}{4}$, *broadest on costal half, with a sharp deep serration inwards below middle ; second fascia broad, very slightly sinuate and becoming narrow near dorsum* ; traces of a narrow orange fascia on costa at middle and before apex : *cilia orange*. Hindwings dark fuscous irrorated with yellow ; a prominent median yellow fascia, becoming narrow and bending inwardly on dorsum ; an obscure irregular yellow subterminal line : *cilia orange*. Undersides : Forewings brownish-orange ; upper lines partially reproduced and suffusedly margined with fuscous ; several bright orange-brown blotches on costa : hindwings brownish-orange ; an outwardly oblique irregular white median fascia ; a pale subterminal line.

Nearest to *Dasyuris callicrena* Meyr., but differing in the form of the lines and the unicolourous cilia. It is possible that the species is a *Notoreas*, the absence of the antennae making the point difficult to decide.

A single ♂ taken on Bold Peak in February by Mr. W. G. Howes. Type in coll. Dominion Museum.

Notoreas opipara sp. nov.

♂ ♀. 18–21 mm. Head and palpi black, in ♀ with some admixture of white, palpal hairs long and dense. Antennae black, moderately bipectinated. Thorax black with some white scales, sometimes mixed with reddish. Abdomen black, segmental divisions whitish-ochreous, anal tuft mixed with brownish-ochreous. Forewings rather short, costa strongly arched at base, subsinuate, very slightly arched on apical half, termen bowed, oblique; *black with a slight sprinkling of white scales;* basal line white, obscure, angled at middle; first line from ¼ costa to ⅓ dorsum, white, irregular, outwardly oblique to middle, thence almost straight to dorsum; space between basal and first line orange-reddish, in darker specimens very faintly indicated; an orange-red line parallel to and near first line and a similar line before second line, both often obsolete; a black discal dot, *usually suffusedly margined with white* which sometimes continues as an obscure median line; *second line from ¾ costa, white, roundly projecting above and at middle, inwardly oblique below middle, thence obliquely to dorsum at ¾*; second line followed by a broad orange-red line, often obscure or obsolete; in some specimens a thin interrupted whitish, subterminal line: cilia whitish-ochreous, basal half and a series of bars blackish. Hindwings fuscous-black; a black discal dot; a suffused pale-ochreous second line, bent outwardly at middle; an obscure pale subterminal line: cilia as in forewings. Undersides: Forewings fuscous, basal half of costa broadly ochreous; second line broad, ochreous; several alternate fuscous and ochreous striae between discal dot and second line: hindwings fuscous; some obscure ochreous striae before second line; second line broadly and suffusedly ochreous; a dentate ochreous subterminal line, in dark specimens obscure.

A very distinct form, probably nearest to *Notoreas orphnaea* Meyr., but little more than half the size of that species. From *N. anthracias* Meyr., to which it also shows some affinity, it is distinguished by the darker colour, presence of reddish striae, and longer palpal hairs.

Table Hill and Rakiahua, Stewart Island, in December. Eight specimens, on the open hilltops at about 2,000 ft.

SELIDOSEMIDAE.

Selidosema terrena sp. nov.

♂. 49 mm. Head grey mixed with brown. Antennae dull brown, ciliations long. Thorax brown mixed with grey. Abdomen grey. Legs grey, sprinkled and annulated with fuscous-brown. Forewings triangular, costa straight, termen evenly rounded, oblique; *whitish-grey, densely irrorated with brownish-fuscous which forms indistinct basal, first, second, and subterminal fasciae;* a rather large inwardly oblique discal dot: cilia (incomplete) grey mixed with brown. Hindwings *greyish-white*, minutely sprinkled with brownish-fuscous: cilia grey.

In form of wing and antennal structure nearest to *Selidosema productata* Walk.; the grey hindwings, however, at once separate it from that species.

Bold Peak, in February. A single ♂ taken by Mr. H. Hamilton. Type (♂) in coll. Dominion Museum.

Selidosema albafasciata sp. nov.

♂ ♀. 32–34 mm. Head and thorax ochreous mixed with brown. Antennae brown, annulated with ochreous, ciliations rather short. Abdomen ochreous. Forewings moderate, triangular, costa subsinuate,

termen evenly rounded, not strongly oblique; dark greenish-fuscous with some admixture of yellowish; markings white tinted with yellow and sparsely sprinkled with brown; *a broad band at $\frac{1}{8}$ slightly curved; median and second fasciae broad, coalescing at middle and enclosing a triangular blotch of ground-colour on costa;* sometimes throwing out a projection to middle of termen, thus interrupting the broad dark terminal area; a terminal series of irregular blackish dots: cilia ochreous mixed with brown. Hindwings pale yellow sprinkled with fuscous; a more or less interrupted brown terminal line: cilia yellow obscurely barred with brown.

The ♀ differs in having much of the dark ground-colour replaced by the lighter shade of the markings. The basal patch and median band are much reduced, and the terminal dark area is represented only by a triangular subapical patch and some small marks on the lower half. Possibly, however, the specimen is a variety, and the markings of the normal female may more closely resemble those of the male.

The species has some affinity with *Selidosema melinata* Feld., but differs strikingly in the presence of the broad white first line.

Taihape, in February, and Feilding, in March. A ♂ taken in each locality by the late Mr. A. Hamilton. The ♀ was secured by Mr. J. H. Lewis, locality uncertain.

Types (♂ and ♀) in coll. Dominion Museum.

Declana sinuosa sp. nov.

♂ ♀. 35-36 mm. Head and thorax reddish-brown, more or less sprinkled with white. Thorax with small posterior crest. Antennae in ♂ shortly bipectinate, in ♀ dentate. Abdomen grey. Forewings, costa strongly arched at base, widely sinuate to apex, termen shortly sinuate beneath apex, strongly rounded, *hardly oblique;* purplish-grey, sometimes mixed with ochreous; a series of inwardly oblique dark strigulae along costa; first line about $\frac{1}{4}$, usually almost obsolete, inwardly oblique, sometimes preceded by a purplish shade; *second line at $\frac{5}{8}$, slightly outwardly oblique, indented above and below middle and followed by suffused purple shade;* a suffused white interrupted fascia from apex to near tornus: cilia dark grey. Hindwings fuscous-grey: cilia grey-whitish with darker median band.

Nearest to *Declana griseata* Hdsn., but with shorter antennal pectinations and termen of forewings much less oblique.

Ben Lomond, in bush, to 3,000 ft. November to March. I am indebted to Mr. M. O. Pasco for several good examples.

CRAMBIDAE.

Crambus oppositus sp. nov.

♂ ♀. 28–32 mm. Head dark ochreous-brown, crown whitish, more pronounced in ♀. Palpi moderate, ochreous-brown, whitish above and beneath in ♀. Thorax dark ochreous-brown with narrow central white stripe, broader in ♀. Abdomen fuscous-grey in ♂, grey-whitish in ♀. Forewings moderate, dilated posteriorly, costa hardly arched, apex almost rectangular, faintly sinuate; *dark ochreous-brown with brassy reflections,* slightly paler in ♀; costal edge usually narrowly whitish (in ♂ ochreous-whitish) throughout, a little dilated at $\frac{3}{4}$; a rather broad straight white central stripe, sometimes margined above and beneath with blackish; dorsum narrowly white throughout: cilia in ♂ brown with basal half white from apex to middle, in ♀ white with grey median line. Hindwings, *in ♂ dark fuscous;* in ♀ white, irregularly suffused with pale fuscous: cilia in ♂ fuscous-grey with two or more fuscous lines, in ♀ shining white.

Allied to *Crambus dicrenellus* Meyr., from which it differs chiefly in the darker tints. The deep-fuscous colouring of the hindwings of the ♂ distinguishes that sex from any other species of the genus at present known in New Zealand.

Hunter Mountains, from 3,000 ft. to 4,000 ft., in January. I have also a single ♂ from The Hump, taken at about 3,000 ft., in January.

Pyraustidae.

Scoparia fumata sp. nov.

♂. 20-23 mm. Head ochreous-brown. Palpi 3, brown, greyish above, white at base beneath. Antennae ochreous, obscurely annulated with brown, ciliations $\frac{3}{4}$. Thorax brown. Abdomen brownish-grey, paler towards base. Forewings moderate, costa almost straight, apex subacute, termen faintly sinuate, slightly oblique; *pale fuscous-brown; markings dark fuscous;* first line obscure, strongly oblique outwardly to middle, thence inward to beneath fold and again outward to dorsum, often obsolete; *orbicular linear,* sometimes dot-like; *claviform more or less elongate;* reniform subquadrate, usually with a projection inwards on lower margin; second line finely dentate, gently curved, parallel to termen, obscurely white-margined posteriorly; a chain of dots on termen: cilia ochreous-brown with 2 darker lines. Hindwings grey, ochreous-tinged; a darker subterminal line, most pronounced on costal portion: cilia ochreous-grey with an obscure darker line.

Distinguished from *Scoparia chalara* Meyr. by the darker colour and the distinct dash-like claviform. The unindented second line at once separates it from *Scoparia octophora* Meyr.

Longwood Range, in December. Five specimens in the open country, at 2,800 ft.

Tortricidae.

Capua arcuata sp. nov.

♀. 15-16 mm. Head, palpi, antennae, and thorax ochreous-whitish sprinkled with reddish. Abdomen ochreous-grey. Forewings oblong, termen sinuate, dorsum straight; whitish, irregularly mixed with pale ochreous; fasciae reddish-ochreous, becoming blackish on margins; basal patch indicated by obscure irregular fascia, almost obsolete on costa and dorsum; median fascia broad, from costa at $\frac{1}{4}$ outwardly oblique to below middle, thence bent upwards again to costa at $\frac{3}{4}$ *enclosing semi-oval area much mixed with white;* one or two costal blotches of reddish-black within this enclosed area: a broad fascia from tornus, parallel to termen and touching median fascia at apex; a narrow white interrupted space between these fasciae; two or three irregular white blotches on costa near apex and a series of obscure dark strigulae along dorsum: cilia white mixed with reddish-brown. Hindwings whitish-grey, suffused and spotted with pale fuscous: cilia greyish-white with a darker basal line.

Distinguished from *Capua plinthoglypta* Meyr. by the shape of the basal patch and the deeper and narrower pale median costal space.

Invercargill, in January. Two specimens.

Eurythecta trimaculata sp. nov.

♂ ♀. 9½-11 mm. Head and palpi grey. Thorax grey, with a posterior curved black band sometimes interrupted at middle. Abdomen dark grey. Forewings moderate, costa slightly arched at base, straight, apex obtuse, termen faintly rounded, oblique; whitish-grey, irrorated with black;

markings black or dark fuscous with bronzy reflections; some spots and strigulations near base; *a broad inwardly oblique fascia at* $\frac{1}{4}$, *often interrupted or obscure on upper half;* three equidistant triangular dots on costa between $\frac{1}{2}$ and apex; a broad irregular fascia from tornus, its apex sometimes touching central costal dot; a terminal suffusion beneath apex, sometimes extending to near tornus: cilia usually grey with a darker line, sometimes wholly greyish-fuscous. Hindwings fuscous-grey, darker round apex: cilia fuscous-grey with a darker line, tips paler.

Near *Eurythecta robusta* Butl., but in that species the fascia are *outwardly* oblique.

Queenstown, in December, on open hillsides from 1,000 ft. to 2,500 ft.

Harmologa sanguinea sp. nov.

♂. 17 18½ mm. Head fuscous mixed with grey. Palpi reddish-brown. Antennae fuscous ringed with ochreous, ciliations 1½. Thorax brownish-red mixed with grey. Abdomen pale fuscous, segmental margins grey. Forewings elongate, costa moderately arched, apex subacute, termen rounded, slightly oblique; *dark purplish-red;* margin of basal patch oblique, almost straight, from $\frac{1}{6}$ to $\frac{1}{3}$; followed by a shining silvery fascia much intermixed with yellow or orange, its outer margin from just beyond costal patch, very oblique to $\frac{2}{5}$, thence less oblique to dorsum at $\frac{1}{2}$; a similarly-coloured median fascia, rather broad, narrowest on costa, usually becoming obsolete at middle; *a similar fascia from tornus, rather oblique inwardly to middle, thence bent acutely downwards and inwards, sometimes obscurely touching median fascia: an obscure subterminal fascia from before apex obliquely to termen at middle:* cilia greyish-fuscous mixed with some reddish and with two darker lines. Hindwings dark fuscous: cilia grey with a darker line.

Easily distinguished from the following form by the differences in the tornal and subterminal fasciae.

Mount Cleughearn, Hunter Mountains, in January. Five males amongst *Veronica* and *Cassinia* bushes, at an elevation of about 3,000 ft.

Harmologa festiva sp. nov.

♂. 16 mm. Head grey. Palpi ferruginous. Antennae fuscous, obscurely ringed with paler, ciliations 1. Thorax fuscous mixed with ochreous-reddish and grey. Abdomen fuscous, segmental divisions grey. Forewings moderate, rather oblong, costa strongly arched, apex obtuse, termen bowed, hardly oblique; *bright ochreous-red; fasciae white;* first fascia, defining basal patch, outwardly oblique, almost straight, narrowest towards costa, its edges suffusedly margined with blackish, clouded above and below middle with ochreous; median fascia broad, dilated in disc, lower half almost filled with ochreous blotch; *subterminal fascia straight, blackish-margined, from* $\frac{5}{6}$ *costa to tornus:* cilia pale ochreous with darker basal line. Hindwings fuscous: cilia as in forewings but paler.

A shorter-winged species than the preceding; the antennal ciliations are also shorter.

Hunter Mountains, in January. Four males taken amongst *Veronica* and other shrubs, at about 3,000 ft.

Harmologa reticularis sp. nov.

♂. 16½ 17½ mm. Head greyish-fuscous. Palpi dark brownish-ochreous. Antennae fuscous ringed with whitish, ciliations 1¼. Thorax fuscous mixed with orange and white. Abdomen fuscous-grey. Forewings rather

elongate, costa moderately arched, apex rounded, termen obliquely rounded; *pale orange;* some irregular leaden-coloured markings within basal patch; first fascia narrow, outwardly oblique, bifid from middle to dorsum, white; median fascia narrow, outwardly oblique, irregular, costal portion white and the lower half breaking up into a network of leaden-coloured fasciae; *a narrow fascia from $\frac{3}{4}$ costa, bifid from middle, anterior limb to $\frac{3}{4}$ dorsum and posterior limb to tornus,* white, leaden-coloured beneath costa and on anterior limb; a white dot, margined beneath with leaden colour, on costa between this fascia and the preceding one; a narrow white subterminal striga, touching termen before tornus: cilia grey mixed with white, tips yellowish. Hindwings greyish-fuscous: cilia greyish-white with darker basal line.

Allied to the two preceding forms, but abundantly distinct in colour and markings. In one specimen the markings are almost wholly leaden-coloured.

Longwood Range, in December. Two males on the bare tops, at about 2,800 ft.

Oecophoridae.

Gymnobathra squamea sp. nov.

♂. 12 mm. Head dark fuscous with a few yellow scales. Palpi bright yellow, fuscous beneath. Antennae fuscous. Thorax dark fuscous mixed with yellow. Abdomen fuscous broadly annulated with grey. Forewings moderate, costa moderately arched, apex obtuse, termen almost straight, somewhat oblique; *bright golden-yellow irrorated and suffused, especially near base, with fuscous:* cilia dark fuscous. *Hindwings dark fuscous:* cilia grey-whitish with fuscous basal line.

Not closely related to any other *Gymnobathra.*

Hunter Mountains, in January. Three examples, at 3,500 ft.

Cremnogenes robiginosa sp. nov.

♂ ♀. 18–19 mm. Head, palpi, antennae, thorax, and abdomen dark fuscous; patagiae tipped with whitish or ochreous; antennal ciliations whorled, 3½. Forewings elongate, costa moderately arched, apex rounded, termen slightly rounded, oblique; *dark shining ferruginous with some ochreous admixture; a reddish-ochreous patch on dorsum at base; a semi-oval ochreous patch, tinged with reddish and margined with white above, on dorsum at middle:* cilia dark ferruginous. Hindwings dark fuscous: cilia dark fuscous with darker basal line.

The single ♀ taken has the forewings entirely pale ochreous except that the median dorsal patch is indicated by a broad margin of ferruginous.

Distinguished from *Cremnogenes nigra* Philp. by the ground-colour and shorter antennal ciliations, and from *Cremnogenes monodonta* Meyr. by the character of the markings at dorsum.

Longwood Range, on the open tops at about 2,700 ft., in December; and Mount Cleughearn, Hunter Mountains, at 3,000 ft. to 3,500 ft., amongst *Veronica,* in January. Five males and one female.

Gelechiadae.

Orthenches semifasciata sp. nov.

♂ ♀. 16–18 mm. Head, palpi, and thorax white mixed with brown. Abdomen grey. Forewings elongate, costa gently arched, apex subacute, termen rounded, oblique; white, irrorated with shining dark brown, especially on dorsal half; markings shining dark brown; basal fascia indicated

by outwardly oblique mark in disc; *median fascia rather narrow, irregular, outwardly strongly oblique, obsolete on lower half:* a blotch on costa at $\frac{3}{4}$ and one or two smaller ones between this and apex; termen broadly dark brown, indented by apical white area: cilia dark brown, paler round tornus. *Hindwings light fuscous-grey:* cilia grey with darker basal shade.

Near *Orthenches porphyritis* Meyr., but longer-winged and with less metallic lustre. The hindwings are distinctly paler.

I am indebted to Mr. C. C. Fenwick for the loan of a fine specimen for description. It was taken at Queenstown, in January. I met with a few worn examples at Hakapoua, Fiord County, in March. Type in coll. C. C. Fenwick.

TINEIDAE.

Dryadaula castanea sp. nov.

♂. 9-10 mm. Head and palpi white mixed with pale brownish-yellow. Antennae white annulated with ochreous and with three broad darker bands on apical half. Thorax bright ochreous. Abdomen ochreous-fuscous, anal tuft ochreous. Forewings, costa gently arched, apex subacute, termen very oblique; *bright brownish-yellow; a thin white line from base along fold to* $\frac{1}{3}$; *a narrow white straight fascia from costa at* $\frac{1}{3}$ *to dorsum at* $\frac{2}{3}$; *a similar fascia from costa at* $\frac{2}{3}$ *to tornus, slightly outwards-curved, rather suffused beneath costa and sending out one or two white streaks towards termen; a white fascia from dorsum near base to extremity of basal line; a second dorsal fascia from* $\frac{1}{2}$, *touching first costal fascia beneath middle;* a chain of black spots round apex and along termen, anteriorly margined with white: cilia reddish-brown. Hindwings and cilia fuscous-grey.

A much darker species than *Dryadaula myrrhina* Meyr.; the distinct white lines are also good distinguishing characters.

In bush at the Bluff and Invercargill during November and December. Not common.

ART. XXVI.—*Descriptions of New Zealand* Lepidoptera.

By E. MEYRICK, B.A., F.R.S.

Communicated by Dr. Charles Chilton.

[*Read before the Philosophical Institute of Canterbury, 2nd December, 1914.*]

I AM once more indebted to Messrs. G. V. Hudson and A. Philpott for interesting consignments of *Lepidoptera*, amongst which were included the following species.

HYDRIOMENIDAE.

Hydriomena subrectaria Guen.

(*Coremia subrectaria* Guen., Phal. x, 411; *Cidaria responsata* Walk., Cat. xxv, 1409; *Melanthia casta* Butl., Cist. Ent. ii, 553; *Hydriomena subrectaria* Meyr., Proc. Linn. Soc. N.S. Wales 1890, 829.)

Queenstown, in December (Philpott). I am not aware that this species has been recorded previously from New Zealand; it is common in south-east Australia.

Xanthorhoe sericodes n. sp.

♂. 33–34 mm. Head, palpi, and thorax pale greyish-ochreous. Antennal pectinations 6. Abdomen pale ochreous, sometimes with double dorsal series of small cloudy dark-fuscous dots. Forewings triangular, costa hardly arched, apex obtuse, termen rounded, rather oblique; pale greyish-ochreous; in one specimen a transverse dark-fuscous discal dot, and some faint paired fuscous dots on termen, in the other these are wholly absent: cilia whitish-ochreous. Hindwings and cilia whitish-ochreous tinged with grey; in one specimen a faint grey discal dot.

Mount Earnslaw, 4,000 ft., in January (Hudson): two specimens.

SELIDOSEMIDAE.

Selidosema scariphota n. sp.

♂. 32 mm. Head pale ochreous. Palpi pale ochreous mixed with fuscous. Antennal pectinations 8. Thorax pale ochreous, anteriorly suffused with fuscous. Abdomen whitish-ochreous mixed with fuscous. Forewings triangular, costa slightly arched, apex obtuse, termen rounded, rather oblique; pale yellow-ochreous, strewn with fine scattered dark-fuscous strigulae, with a patch of longer and thicker strigulae in middle of disc; costa marked with small blackish spots and strigulae, costal area tinged with fuscous; first and second lines slender, even, dark fuscous, nearly parallel to termen, not nearly reaching costa, first double in lower part of disc, not reaching dorsum, second somewhat curved, thickest towards dorsum; a transverse-linear blackish discal mark on end of cell; a light fuscous terminal fascia, terminated abruptly above by a short rather oblique dark-fuscous streak from beneath apex; a terminal series of short black marks or dots: cilia whitish-ochreous with a fuscous subbasal line, basal area slenderly barred with fuscous, with a longer dark-fuscous bar on subapical streak. Hindwings light ochreous-yellowish; terminal line partially marked with dark fuscous: cilia ochreous-whitish, with a grey line.

One specimen, bred by Mr. Sunley from a larva on "New Zealand broom" (presumably *Carmichaelia*), communicated by Mr. Hudson. A very distinct species.

PHYCITIDAE.

Plodia interpunctella Hüb.

An introduced domestic species, taken by Mr. Hudson in the General Post Office at Wellington; easily recognized by the dark ferruginous-fuscous forewings with basal area wholly whitish-ochreous. The larva feeds on grain (especially maize), figs, &c., and the moths may sometimes be found plentifully in corn-bins. The species is widely spread by artificial means in Europe, North America, and Australia.

PYRAUSTIDAE.

Scoparia atmogramma n. sp.

♂. 23–24 mm. Head and thorax light grey more or less mixed with whitish. Palpi 3, light grey, white towards base beneath. Antennal ciliations ¾. Abdomen pale greyish-ochreous. Forewings elongate, very narrow towards base, gradually dilated posteriorly, apex obtuse, termen slightly rounded, rather oblique; ochreous-grey, usually more or less suffused with whitish on veins, interneural spaces more or less suffusedly sprinkled

with dark fuscous; claviform indicated by a small spot of dark-fuscous suffusion: cilia white, with a grey line. Hindwings 1½, without long hairs in cell; light grey, paler towards base: cilia white or in one specimen whitish-ochreous, with faint grey line.

Tisbury and West Plains, Invercargill, in September (Philpott); Lake Wakatipu (Hudson); four specimens. Nearest *psammitis*.

TORTRICIDAE.

Harmologa allogama Meyr.

Mr. Hudson has sent me a curious variety of the female, in which the whole forewing is suffused with whitish-ochreous, the pale costal blotch thus becoming obsolete.

GLYPHIPTERYGIDAE.

Simaethis barbigera n. sp.

♀. 19 mm. Head bronzy irrorated with white and dark fuscous. Palpi white, mixed with dark fuscous, second joint with long rough projecting tuft beneath, terminal joint loosely scaled. Thorax greyish-bronze sprinkled with white. Abdomen bronzy-grey, segmental margins white. Forewings elongate, posteriorly dilated, costa gently arched, apex obtuse, termen bowed, oblique; greyish-bronze, irregularly irrorated with white, especially towards costa and on a terminal band; a white transverse dot on end of cell; second line formed of white irroration, strongly curved outwards: cilia pale greyish-ochreous, with dark-grey subbasal line, with patches of whitish suffusion above and below middle of termen. Hindwings light grey; a terminal fascia of irregular white irroration, most pronounced towards middle, obsolete towards apex: cilia pale greyish-ochreous, with dark-grey subbasal line, tips white.

Mount Cleughearn, Hunter Mountains, in January (Philpott); one specimen. A very distinct and interesting new form.

Glyphipteryx rugata n. sp.

♀. 9 mm. Head and thorax ochreous-grey-whitish. Palpi with appressed scales, whitish, with four rings and anterior edge of terminal joint dark fuscous. Abdomen elongate, grey, segmental margins whitish. Forewings elongate, costa gently arched, apex pointed, termen very obliquely rounded; dark fuscous, with about ten very irregular broken and partially confluent silvery-whitish transverse striae, towards apex becoming confused dots: cilia whitish, basal area tinged with fuscous within a black line interrupted with white beneath apex. Hindwings short, narrow, pointed, light grey: cilia whitish.

Tisbury, in January (Philpott); one specimen, beaten with others from *Weinmannia racemosa*. Wings somewhat reduced in proportion to body, the male probably longer-winged.

PLUTELLIDAE.

Plutella megalynta n. sp.

♂. 34 mm. Head ochreous-whitish, sides of crown dark brown; hairs projecting on forehead. Palpi ochreous-whitish, second joint brownish-ochreous except apical edge, tuft long, rough, terminal joint much shorter than second. Antennae whitish-ochreous, ciliation 1, basal joint dark brown, without flap of scales. Thorax brown, with broad ochreous-whitish dorsal

stripe and dark-fuscous stripe on each side of it. Abdomen whitish-grey-ochreous. Forewings elongate, rather narrow, posteriorly slightly dilated, costa gently arched, apex obtuse, termen nearly straight, rather oblique; pale brownish-ochreous, more brownish-tinged in disc and towards dorsum, obscurely streaked with ochreous-whitish suffusion between veins; a narrow ochreous-white dorsal streak from base to $\frac{3}{4}$, edged above with dark-fuscous suffusion anteriorly; an irregular brownish median longitudinal streak from middle of disc to termen, with some blackish scales in longitudinal lines; some dark-brown dots round posterior part of costa and termen: cilia light-brownish, at apex and on costa ochreous-whitish. Hindwings with 3 and 4 approximated at base; ochreous-grey-whitish: cilia concolorous.

Wellington, in November (Philpott); one specimen. This remarkable species is the largest of the genus.

TINEIDAE.

Archyala pentazyga n. sp.

♂. 13 mm. Head fuscous. Palpi fuscous mixed with darker, rough scales of second joint longer than in *paraglypta*. Thorax and abdomen rather dark fuscous. Forewings elongate, narrow, costa slightly arched, apex obtuse, termen slightly rounded, rather strongly oblique; fuscous, with fine rather oblique transverse striae of dark-fuscous scales; five rather narrow oblique transverse dark-fuscous fasciae, first from $\frac{1}{8}$ of costa, interrupted in disc and not reaching dorsum, second and third connected by a suffused patch in disc, third interrupted beneath this, fourth not reaching tornus, fifth curved beneath to termen above tornus: cilia fuscous, with blackish subbasal line. Hindwings rather dark fuscous, lighter and rather thinly scaled towards base: cilia fuscous, with dark-fuscous subbasal line.

Day's Bay, Wellington, in January (Hudson); one specimen.

Tinea argodelta n. sp.

♂. 10 mm. Head and thorax dark purple-fuscous, face whitish-fuscous. Palpi dark fuscous, tip whitish. Abdomen dark fuscous. Forewings elongate, narrow, costa gently arched, apex obtuse-pointed, termen extremely obliquely rounded; dark purple-fuscous; two or three minute whitish strigulae on costa towards $\frac{1}{3}$, a spot of white strigulation in middle of costa, a smaller spot at $\frac{3}{4}$, and three dots between this and apex; a clear white triangular spot on dorsum before middle, reaching nearly half across wing; a spot of whitish strigulation on dorsum before tornus, and two or three whitish scales towards termen: cilia purplish-fuscous with two darker shades, with a white mark towards tips on middle of termen. Hindwings with 5 and 6 separate; dark purple-grey: cilia rather dark grey.

Bluff, in February (Philpott); one specimen. Allied to *margaritis*, but apparently distinct by the character of antemedian dorsal spot, and the separation of veins 5 and 6 of hindwings (in *margaritis* always stalked).

ART. XXVII.—*Revision of New Zealand* Tineina.

By E. MEYRICK, B.A., F.R.S.

Communicated by Dr. Charles Chilton.

[*Read before the Philosophical Institute of Canterbury, 2nd December, 1914.*]

IN pursuance of the series of papers revising the classification of groups of the *Lepidoptera*, I now deal with the *Tineina*. This is in New Zealand, as elsewhere, the largest group, the most interesting for study, and also, on account of the relatively small size of the species, the least studied; doubtless, therefore, there still remain a large number of additional species to be discovered. Expert search by entomologists possessed of good eyesight and acumen, together with careful breeding of larvae, is needed to fill up the list; and special exploration should be made of mountain regions at other times than midsummer; under such circumstances few species would be found, but it is not improbable that they might be of a specially interesting character.

The *Tineina* usually constitute more than a third of the whole *Lepidoptera* of any given region, and this proportion is apparently maintained in New Zealand. Of the 327 species of the group, 119 belong to the *Oecophoridae*, or 36 per cent.; only in Australia does a similar proportion prevail, the usual ratio being about 9 per cent. It is curious that in the Hawaiian Islands, which have some faunal analogy with New Zealand (*e.g.*, the great preponderance of the genus *Scoparia* in both), the *Oecophoridae* are entirely absent. It is remarkable also that whilst New Zealand agrees with Australia in the numerical prevalence of the *Oecophoridae*, there is little near relationship between the representatives of the two regions, the chief Australian genera (such as *Philobota* and *Eulechria*) being only represented in New Zealand by one or two casual stragglers; the only genus well established in both regions, *Borkhausenia*, is cosmopolitan.

Other marked features are the scanty representation of the usually preponderating family *Gelechiadae*, the considerable development of the *Glyphipterygidae* (especially *Glyphipteryx* itself), and the absence of the *Adelidae*, which is an ancient family and present in all other continental regions (for I consider New Zealand as a continent, or rather the remains of one). These features are difficult to explain on any theory, and at present too little is known of the *Tineina* of the southern parts of South America to estimate accurately the amount of relationship with that region. Certain Glyphipterygid genera (*Heliostibes*, and allies) are undoubtedly of South American origin; so also is the Gelechiad genus *Anisoplaca*. The genera of *Heliodinidae* are all evidently connected with Queensland; the *Cosmopterygidae*, *Gracilariadae*, and *Lyonetiadae* seem also all to have come from the same region.

On a general consideration of the facts it seems that the native fauna is composed of three elements introduced at different periods of time—viz. (1) a South American element, which is the oldest, yet of a geological age not very remote, perhaps the Eocene, previous to which the region was entirely devoid of insects or flowering-plants; to this belong all the larger genera, *Borkhausenia*, *Gymnobathra*, *Trachypepla*, *Izatha*, *Simaethis*, *Glyphipteryx* (in part), and the *Micropterygidae* (which for convenience I

also deal with now), and a very few of the smaller genera, this fauna having been of a very limited character, and further restricted by the nature of the Antarctic lands through which the transmission was effected : (2) a mingled Australian and Indo-Malayan element derived from Queensland and the South Pacific by way of New Caledonia at a later period, conjecturally the Miocene, and including most of the smaller genera ; at the same time a slight cross-immigration of the earlier element into Queensland took place (*Trachypepla*, *Sabatinca*) : (3) a small Tasmanian element, which has made its way (wind-borne) into New Zealand in quite recent times, the species being identical and unmodified (*e.g.*, *Cateristis*). A fourth element of artificially introduced species is now being superadded.

The generic and family characters given only hold good for the New Zealand species, and synonymy and references are restricted to those of local use.

1. Gelechiadae.

Head with appressed scales. Labial palpi long, recurved, pointed, usually acute. Maxillary palpi very short, appressed. Forewings with 2 usually from near angle, 7 and 8 stalked, 7 to costa. Hindwings more or less trapezoidal, termen sinuate or emarginate ; 6 and 7 usually approximated or stalked.

An immense family, abundant in all the main regions, but less prominent in Australia, and only scantily represented in New Zealand. The species are often inconspicuous and of retired habits, but are undoubtedly really scarce here.

1. Epiphthora Meyr.

Epiphthora Meyr., Trans. N.Z. Inst. xx, 77 (1888) ; type, *melanombra* Meyr.

Basal joint of antennae with pecten. Labial palpi with scales of second joint rough beneath towards apex, terminal joint much shorter, roughened anteriorly. Hindwings under 1, termen abruptly emarginate beneath acutely produced apex ; 3 and 4 rather approximated, 5 nearly parallel, 6 and 7 rather approximated towards base.

A genus of some extent in Australia, and occurring also in the Indian and African regions, but easily overlooked. The structural particulars originally given by me are in part inaccurate.

1. *E. melanombra* Meyr., Trans. N.Z. Inst. 1887, 77.
Christchurch. Larva mining in leaves of *Olearia avicenniaefolia*.

2. Megacraspedus Zell.

Megacraspedus Zell., Isis 1839, 189 (1839) ; type, *dolosellus* Zell.

Basal joint of antennae without pecten. Labial palpi with second joint tufted towards apex beneath, terminal joint as long as second. Hindwings with termen emarginate beneath produced apex ; 3 and 4 remote, 5 nearer 6, 6 and 7 remote.

A genus of wide distribution, more developed in Australia than elsewhere.

2. *M. calamogona* Meyr., Trans. N.Z. Inst. 1885, 163.
Christchurch, Invercargill. Larva in seed-heads of *Arundo conspicua*.

3. Aristotelia Hüb.

Aristotelia Hüb., Verz. 424 (1826); type, *decurtella* Hüb. *Isochasta* Meyr., Trans. N.Z. Inst. xviii, 163 (1886); type, *paradesma* Meyr.

Basal joint of antennae without pecten. Labial palpi with second joint roughened beneath, terminal joint nearly as long, somewhat thickened. Forewings with 6 and 7 out of 8. Hindwings with termen emarginate beneath acute apex; 3 and 4 remote, 5 nearer 6 than 4, 6 and 7 remote.

A large genus of general distribution.

3. *A. paradesma* Meyr., Trans. N.Z. Inst. 1885, 163.
   Invercargill.

4. Thiotricha Meyr.

Thiotricha Meyr., Trans. N.Z. Inst. xviii, 164 (1886); type, *thorybodes* Meyr.

Antennae in ♂ with long fine ciliations, basal joint without pecten. Labial palpi with second joint smooth, terminal joint as long as second. Forewings with 4 absent, 6 out of 7 or separate, 8 absent. Hindwings with termen sinuate beneath pointed apex: 3 and 4 connate, 5 rather approximated, 6 and 7 stalked.

Fairly well developed in the Indian and Australian regions.

4. *T. tetraphala* Meyr., Trans. N.Z. Inst. 1885, 164
   Whangarei, Dunedin, Lake Wakatipu.
5. *T. thorybodes* Meyr., Trans. N.Z. Inst. 1885, 164.
   Wellington, Christchurch.

5. Phthorimaea Meyr.

Phthorimaea Meyr., Ent. M. Mag. xxxviii, 103 (1902); type, *operculella* Zell.

Basal joint of antennae without pecten. Labial palpi with second joint expanded with rough projecting scales beneath, terminal joint as long as second or shorter. Hindwings 1 or hardly over, with termen sinuate beneath acute apex; 3 and 4 connate, 5 somewhat approximated, 6 and 7 remote or approximated at base, posteriorly parallel.

A very extensive genus of wide distribution.

6. *P. operculella* Zell., Zool. Bot. Ver. 1873, 262: *terrella* Walk., Cat. xxx, 1024 (*praeocc.*): *solanella* Boisd., J.B. Soc. Centr. Hort. 1874, 713; Meyr., Trans. N.Z. Inst. 1885, 166.
   Taranaki, Napier, Nelson, Christchurch: a native of North America, now widely spread in Australia, Africa, and Europe. Larva in tubers of potato (*Solanum nigrum*); very destructive.
7. *P. thyraula* Meyr., Trans. N.Z. Inst. 1885, 167.
   Christchurch, Castle Hill.
8. *P. brontophora* Meyr., Trans. N.Z. Inst. 1885, 168.
   Christchurch, Invercargill.
9. *P. cheradias* Meyr., Trans. N.Z. Inst. 1908, 12.
   Invercargill.
10. *P. glaucoterma* Meyr., Trans. N.Z. Inst. 1910, 63.
    Invercargill.
11. *P. hippeis* Meyr., Trans. Ent Soc. Lond. 1901, 573.
    Christchurch.

6. Gelechia Hüb.

Gelechia Hüb., Verz. 415 (1826); type, *rhombella* Schiff.

Basal joint of antennae without pecten. Labial palpi with second joint expanded, with rough projecting scales beneath, terminal joint as long as second or shorter. Hindwings over 1, termen somewhat sinuate beneath apex; 3 and 4 connate, 5 rather approximated, 6 and 7 approximated at base or stalked, posteriorly diverging.

A very large genus, principally characteristic of Europe, Africa, and America.

12. *G. schematica* Meyr., Trans. N.Z. Inst. 1885, 168.
Castle Hill, Bealey River.

13. *G. parapleura* Meyr., Trans. N.Z. Inst. 1885, 168.
Bealey River.

14. *G. pharetria* Meyr., Trans. N.Z. Inst. 1885, 169.
Castle Hill, Arthur's Pass, Mount Arthur; 2,500–4,000 ft.

15. *G. monophragma* Meyr., Trans. N.Z. Inst. 1885, 169.
Hamilton, Napier, Wellington, Invercargill.

16. *G. lithodes* Meyr., Trans. N.Z. Inst. 1885, 170.
Castle Hill, Bealey River, Arthur's Pass, Lake Wakatipu.

7. Anisoplaca Meyr.

Anisoplaca Meyr., Trans. N.Z. Inst. xviii, 171 (1886); type, *ptyoptera* Meyr.

Basal joint of antennae without pecten. Labial palpi with second joint densely scaled, with rough projecting scales beneath towards apex, prominent below apex, terminal joint as long as second or longer, stout. Hindwings over 1, termen hardly sinuate beneath obtuse apex; 3 and 4 connate, 5 approximated, 6 and 7 near and parallel on basal half, diverging posteriorly.

Occurs also in South America and South Africa.

17. *A. acrodactyla* Meyr., Trans. N.Z. Inst. 1906, 118.
Invercargill.

18. *A. achyrota* Meyr., Trans. N.Z. Inst. 1885, 170.
Christchurch, Dunedin. Lake Wakatipu.

19. *A. ptyoptera* Meyr., Trans. N.Z. Inst. 1885, 171.
Christchurch.

2. Cosmopterygidae.

Head smooth. Labial palpi long, recurved, acute. Maxillary palpi very short, appressed. Forewings with 1*b* furcate, 2 from near angle, 7 and 8 stalked, 7 to costa. Hindwings lanceolate, 2–4 remote, parallel, 6 and 7 basally approximated or stalked.

A considerable family of general distribution, little represented in New Zealand.

8. Pyroderces Herr.-Schäff.

Pyroderces Herr.-Schäff., Schmett. Eur. v, 47 (1854); type, *argyrogramma* Zell.

Labial palpi very long, slender, terminal joint longer than second. Forewings without tufts; 6 and 7 out of 8.

Principally characteristic of the Indian and Australian regions.

20. *P. apparitella* Walk., Cat. xxx, 1027; Meyr., Trans. N.Z. Inst. 1888, 174.
Auckland, Wellington.

21. *P. aellotricha* Meyr., Trans. N.Z. Inst. 1888, 175.
Hamilton; also Kermadec Islands.

22. *P. anarithma* Meyr., Trans. N.Z. Inst. 1888, 175.
Taranaki, Napier, Palmerston, Masterton, Wanganui, Wellington; also common in Australia.

9. Limnoecia Staint.

Limnoecia Staint., Cat. Brit. Tin. Suppl. 4 (1851); type, *phragmitella* Staint.

Labial palpi very long, slender, terminal joint longer than second. Forewings without tufts, 6 separate.

A genus of some extent, with the same distribution as *Pyroderces*.

23. *L. phragmitella* Staint., Cat. Brit. Tin. Suppl. 4; Meyr., Trans. N.Z. Inst. 1888, 173.
Hamilton; also in Australia, Africa, and Europe. Probably of wide natural distribution, but it is very retired in habit and rarely captured, though easily bred in plenty. Larva in seed-heads of *Typha*.

10. Zapyrastra Meyr.

Zapyrastra Meyr., Trans. N.Z. Inst. xxi, 171 (1889); type, *calliphana* Meyr.

Labial palpi moderate, slender, terminal joint shorter than second. Forewings with slight tufts of scales; 6 separate, 9 absent. Hindwings with 5 and 6 stalked.

The single species is perhaps Australian by origin.

24. *Z. calliphana* Meyr., Trans. N.Z. Inst. 1888, 172.
Wellington, Christchurch, Bealey River.

11. Microcolona Meyr.

Microcolona Meyr., Proc. Linn. Soc. N.S. Wales 1897, 370 (1897); type, *characta* Meyr.

Labial palpi long, loosely scaled, terminal joint shorter than second. Forewings with tufts of scales; 4 absent, 6 out of 7 or absent. Hindwings with 3 absent, 4 usually absent.

Fairly developed in Australian and Indian regions, but the species are easily overlooked.

25. *M. characta* Meyr., Proc. Linn. Soc. N.S. Wales 1897, 374.
Wellington, Nelson; also in Australia.

26. *M. limodes* Meyr., Proc. Linn. Soc. N.S. Wales 1897, 372.
Christchurch.

12. Syntomactis Meyr.

Syntomactis Meyr., Trans. N.Z. Inst. xxi, 173 (1889); type, *deamatella* Walk.

Labial palpi long, second joint with projecting whorls of scales, terminal joint as long as second, roughened anteriorly. Forewings with tufts of scales; 7 and 8 out of 6.

A considerable genus, characteristic of Australia.

27. *S. deamatella* Walk., Cat. xxix, 654; Meyr., Trans. N.Z. Inst. 1888, 173.
Christchurch, Invercargill.

3. Elachistidae.

Head smooth. Basal joint of antennae with pecten. Labial palpi moderate, curved, pointed. Maxillary palpi very short, appressed. Forewings with 1*b* simple, 6 and 7 stalked 7 to costa, 8 out of 7 or absent. Hindwings lanceolate, 2–4 nearly parallel, 5 absent, 6 and 7 stalked.

13. Elachista Treitsch.

Elachista Treitsch., Schmett. Eur. ix (2), 177 (1833); type, *bifasciella* Treitsch.

An extensive genus, widely distributed but principally known from Europe; the species are often overlooked. Larvae mining in grasses.

28. *E. archaeonoma* Meyr., Trans. N.Z. Inst. 1888, 179.
Auckland, Wellington, Nelson, Dunedin.

29. *E. ombrodoca* Meyr., Trans. N.Z. Inst. 1888, 179.
Christchurch, Dunedin, Invercargill.

30. *E. exaula* Meyr., Trans. N.Z. Inst. 1888, 178.
Mount Arthur (4,000 ft.), Mataura River.

31. *E. helonoma* Meyr., Trans. N.Z. Inst. 1888, 178.
Christchurch.

32. *E. thallophora* Meyr., Trans. N.Z. Inst. 1888, 178.
Christchurch (Kaiapoi), Mount Arthur (4,000 ft.).

33. *E. gerasmia* Meyr., Trans. N.Z. Inst. 1888, 177.
Hamilton, Makatoku, Invercargill; also common in Australia.

34. *E. melanura* Meyr., Trans. N.Z. Inst. 1888, 177.
Hamilton; also in Australia.

4. Scythridae.

Head smooth. Labial palpi moderate, curved, pointed. Maxillary palpi very short, appressed. Forewings with 1*b* simple or short-furcate, 2 from angle, 6 and 7 stalked, 7 to costa, 8 absent. Hindwings lanceolate; veins all separate, nearly parallel.

14. Scythris Hüb.

Scythris Hüb., Verz. 414 (1826); type, *chenopodiella* Hüb.

A large genus, of general distribution, but more especially European.

35. *S. epistrota* Meyr., Trans. N.Z. Inst. 1888, 161.
Christchurch, Mount Arthur (4,500 ft.).

5. OECOPHORIDAE.

Head with appressed hairs. Labial palpi long, recurved, acute. Maxillary palpi very short, appressed. Forewings with *1b* furcate, 2 from near angle, 7 and 8 stalked. Hindwings from trapezoidal-ovate, elongate-ovate, or ovate-lanceolate; 3 and 4 connate, seldom approximated, 5–7 nearly parallel, rarely 6 and 7 stalked.

A very large family, but especially characteristic of Australia and New Zealand; it is also well developed elsewhere, but does not form nearly so large a proportion of the whole fauna as it does in these two regions. It is very remarkable that under these circumstances the Australian and New Zealand representatives of the family are not at all nearly related together, and evidently do not proceed from an immediate common origin.

Group A. Oecophorides.

Antennae in ♂ regularly ciliated; 7 of forewings to costa.

15. Endrosis Hüb.

Endrosis Hüb., Verz. 401 (1826); type, *lacteella* Schiff.

Hindwings ovate-lanceolate; 5 absent.

The single species is domestic and artificially introduced in many parts of the world, its origin being uncertain.

36. *E. lacteella* Schiff., Syst. Verz. 139; Meyr., Trans. N.Z. Inst. 1888, 160; *subditella* Walk., Cat. xxix, 657.
North and South Islands; common in houses. Larva on seeds and dry refuse.

16. Schiffermuelleria Hüb.

Schiffermuelleria Hüb., Verz. 421 (1826); type, *schaefferella* Linn.

Basal joint of antennae without pecten. Hindwings ovate-lanceolate.

Moderately numerous; chiefly confined to the Northern Hemisphere

37. *S. orthophanes* Meyr., Trans. Ent. Soc. Lond. 1905, 243.
Auckland, Nelson.

17. Borkhausenia Hüb.

Borkhausenia Hüb., Verz. 420 (1826); type, *minutella* Linn. *Cremnogenes* Meyr., Trans. N.Z. Inst. xvi, 45 (1884); type, *oxyina* Meyr.

Basal joint of antennae with pecten. Hindwings elongate-ovate or ovate-lanceolate.

A large genus of general distribution, but proportionately more numerous in New Zealand than anywhere else. The larvae probably feed on dry vegetable matter (bark, dead wood, dry leaves, &c.) rather than on growing plants; many of the species are common, and the larvae should not be difficult to find in spring.

38. *B. chrysogramma* Meyr., Trans. N.Z. Inst. 1883, 44.
Wellington, Mount Arthur, Lake Wakatipu.

39. *B. loxotis* Meyr., Trans. Ent. Soc. Lond. 1905, 241.
Wellington.

40. *B. hoplodesma* Meyr., Trans. N.Z. Inst. 1883, 44; Trans. Ent. Soc. Lond. 1901, 574.
Rakaia, Ben Lomond.

41. *B. paratrimma* Meyr., Trans. N.Z. Inst. 1909, 65.
Invercargill.

42. *B. siderodeta* Meyr., Trans. N.Z. Inst. 1883, 43.
Auckland, Wellington, Christchurch, Dunedin, Lake Wakatipu, Invercargill.

43. *B. melanamma* Meyr., Trans. Ent. Soc. Lond. 1905, 240.
Dunedin, Invercargill.

44. *B. maranta* Meyr., Proc. Linn. Soc. N.S. Wales 1885, 791.
Dunedin, Mount Earnslaw, Invercargill.

45. *B. thranias* Meyr., Trans. Ent. Soc. Lond. 1905, 240.
Whangarei.

46. *B. horaea* Meyr., Trans. N.Z. Inst. 1883, 40.
Castle Hill, Bealey River.

47. *B. macarella* Meyr., Trans. N.Z. Inst. 1883, 43.
Wellington, Christchurch.

48. *B. anaema* Meyr., Trans. N.Z. Inst. 1883, 42.
Lake Wakatipu.

49. *B. apanthes* Meyr., Trans. N.Z. Inst. 1883, 41.
Hamilton, Cambridge.

50. *B. armigerella* Walk., Cat. xxix, 698; Meyr., Trans. N.Z. Inst. 1883, 41: *actinias* Meyr., Trans. Ent. Soc. Lond. 1901, 574.
Wellington, Greymouth, Dunedin, Lake Wakatipu, Invercargill.

51. *B. pharmactis* Meyr., Trans. Ent. Soc. Lond. 1905, 241.
Mount Arthur.

52. *B. apertella* Walk., Cat. xxix, 698; *bifaciella* ibid. 810; *oporaea* Meyr., Trans. N.Z. Inst. 1883, 40.
Wellington, Mount Arthur, Castle Hill, Lake Wakatipu, Invercargill.

53. *B. eriphaea* Meyr., Trans. N.Z. Inst. 1913, 107.
Ben Lomond.

54. *B. phegophylla* Meyr., Trans. N.Z. Inst. 1883, 39.
Lake Wakatipu.

55. *B. perichlora* Meyr., Trans. N.Z. Inst. 1906, 119.
Invercargill.

56. *B. basella* Walk., Cat. xxviii, 492; Meyr., Trans. N.Z. Inst. 1906, 119: *ademptella* Walk., Cat. xxix, 698.
Wellington.

57. *B. politis* Meyr., Trans. N.Z. Inst. 1887, 81.
Wellington.

58. *B. pronephela* Meyr., Trans. N.Z. Inst. 1906, 120.
Invercargill.

59. *B. chloradelpha* Meyr., Trans. Ent. Soc. Lond. 1905, 239.
Wellington.

60. *B. siderota* Meyr., Trans. N.Z. Inst. 1887, 82.
Mount Arthur, 4,000–4,500 ft.

61. *B. epichalca* Meyr., Proc. Linn. Soc. N.S. Wales 1885, 793.
Arthur's Pass.

62. *B. aphrontis* Meyr., Trans. N.Z. Inst. 1883, 46.
Arthur's Pass, Mount Arthur.

63. *B. oxyina* Meyr., Trans. N.Z. Inst. 1883, 45.
Lake Wakatipu.

64. *B. monodonta* Meyr., Trans. N.Z. Inst. 1910, 75; *nigra* Philp., Trans. N.Z. Inst. 1913, 120.
Mount Holdsworth, Lake Wakatipu.

65. *B. nycteris* Meyr., Trans. N.Z. Inst. 1889, 219: ibid. 1910, 63.
Wellington, Otira River, Invercargill.

66. *B. homodoxa* Meyr., Trans. N.Z. Inst. 1883, 43.
Lake Wakatipu.

67. *B. griseata* Butl., Proc. Zool. Soc. Lond. 1877, 405.
I am now doubtful whether this is identical with any species known to me.

68. *B. innotella* Walk., Cat. xxix, 652; *griseata* Meyr., Trans. N.Z. Inst. 1883, 39.
Whangarei, Auckland, Napier, Wellington, Nelson, Christchurch, Castle Hill, Dunedin, Invercargill.

69. *B. brachyacma* Meyr., Trans. N.Z. Inst. 1908, 13.
Invercargill.

70. *B. penthalea* Meyr., Trans. Ent. Soc. Lond. 1905, 239.
Wellington.

71. *B. cenchrias* Meyr., Trans. N.Z. Inst. 1908, 13.
Invercargill.

72. *B. hemimochla* Meyr., Trans. N.Z. Inst. 1883, 38.
Hamilton, Cambridge, Napier, Wellington.

73. *B. amnopis* Meyr., Trans. N.Z. Inst. 1909, 65; ibid. 1910, 65.
Invercargill.

74. *B. plagiatella* Walk., Cat. xxviii, 485; Meyr., Trans. N.Z. Inst. 1910, 64: *contextella* Walk., Cat. xxix, 656.
Wellington, Nelson, Otira River.

75. *B. crotala* n. sp.; *contextella* Meyr. (*nec* Walk.), Trans. N.Z. Inst. 1883, 37; ibid. 1910, 64.
Christchurch, Dunedin, Invercargill, Lake Wakatipu.

76. *B. epimylia* Meyr., Trans. N.Z. Inst. 1883, 36.
Nelson, Bealey River, Castle Hill.

77. *B. chloritis* Meyr., Trans. N.Z. Inst. 1883, 36.
Wellington, Lake Wakatipu.

78. *B.letharga* Meyr., Trans. N.Z. Inst. 1883, 35.
Dunedin.

79. *B. asphaltis* Meyr., Trans. N.Z. Inst. 1910, 65.
Central Otago (?).

80. *B. scholaea* Meyr., Trans N.Z. Inst. 1883, 35.
Whangarei, Wellington. Nelson, Christchurch, Dunedin, Invercargill. Larva in a subterranean tube on roots of trees.

81. *B. pseudospretella* Staint., Cat. Brit. Tin. 14; Meyr., Trans. N.Z. Inst. 1883, 34.
North and South Islands, Chatham Islands: common in houses; introduced from Europe, but of doubtful origin. Larva on seeds and dry refuse

18. Compsistis Meyr.

Compsistis Meyr., Trans. N.Z. Inst. xx, 89 (1888); type, *bifaciella* Walk.

Antennae as long as forewings, basal joint without pecten. Hindwings elongate-ovate.
Endemic.

82. *C. bifaciella* Walk., Cat. xxix, 657; Meyr., Trans. N.Z. Inst. 1887, 90.
Whangarei, Auckland, Wellington.

19. Thamnosara Meyr.

Thamnosara Meyr., Trans. N.Z. Inst. xvi, 27 (1884); type, *sublitella* Walk.

Basal joint of antennae without pecten. Second joint of labial palpi with projecting tuft of scales beneath. Hindwings elongate-ovate.
Also endemic.

83. *T. sublitella* Walk., Cat. xxix, 654; *chirista* Meyr., Trans. N.Z. Inst. 1883, 27.
Whangarei, Wellington, Christchurch, Mount Arthur (to 4,000 ft.).

20. Gymnobathra Meyr.

Gymnobathra Meyr., Proc. Linn. Soc. N.S. Wales vii, 425 (1883); type, *flavidella* Walk.

Basal joint of antennae without pecten. Forewings with 2 rather remote from angle. Hindwings elongate-ovate.
Endemic.

84. *G. philadelpha* Meyr., Trans. N.Z. Inst. 1883, 33.
Mount Hutt.

85. *G. hyetodes* Meyr., Trans. N.Z. Inst. 1883, 32.
Kaeo, Wellington.

86. *G. habropis* Meyr., Trans. N.Z. Inst. 1887, 80.
Nelson.

87. *G. hamatella* Walk., Cat. xxix, 700; Meyr., Trans. N.Z. Inst. 1883, 31.
Nelson, Christchurch, Akaroa.

88. *G. flavidella* Walk., Cat. xxix, 655; Meyr., Trans. N.Z. Inst. 1883, 31: *situella* Feld., Reis. Nov. pl. cxl, 46.
Whangarei, Auckland, Taranaki, Wellington, Nelson, Christchurch.

89. *G. sarcoxantha* Meyr., Trans. N.Z. Inst. 1883, 29.
Christchurch, Dunedin.

90. *G. coarctatella* Walk., Cat. xxix, 768 ; Meyr., Trans. N.Z. Inst. 1883, 28.
Wellington, Nelson, Castle Hill.

91. *G. parca* Butl., Proc. Zool. Soc. Lond. 1877, 405 ; Meyr., Trans. N.Z. Inst. 1883, 29 ; *limbata* Butl., Cist. Ent. ii, 560 (1880).
Wellington, Christchurch, Lake Wakatipu, Invercargill.

92. *G. calliploca* Meyr., Trans. N.Z. Inst. 1883, 30.
Wellington, Dunedin.

93. *G. bryaula* Meyr., Trans. Ent. Soc. Lond. 1905, 238.
Wellington.

94. *G. thetodes* Meyr., Trans. Ent. Soc. Lond. 1901, 574.
Akaroa, Oakley.

95. *G. tholodella* Meyr., Trans. N.Z. Inst. 1883, 30.
Hamilton, Palmerston, Christchurch, Dunedin.

96. *G. omphalota* Meyr., Trans. N.Z. Inst. 1887, 81.
Wellington. Christchurch, Lake Wakatipu.

21. Aochleta Meyr.

Aochleta Meyr., Proc. Linn. Soc. N.S. Wales vii, 425 (1883) ; type, *psychra* Meyr.

Basal joint of antennae without pecten. Second joint of labial palpi with rough projecting scales towards apex beneath. Forewings with 2 remote from angle. Hindwings trapezoidal-ovate.
Endemic.

97. *A. psychra* Meyr., Trans. N.Z. Inst. 1883, 21.
Castle Hill.

22. Izatha Walk.

Izatha Walk., Cat. xxix, 786 (1864) ; type, *attactella* Walk. *Semiocosma* Meyr., Proc. Linn. Soc. N.S. Wales vii, 424 (1883) ; type, *peroneanella* Walk.

Basal joint of antennae without pecten. Terminal joint of labial palpi with median scale-projection posteriorly. Forewings with tufts of scales ; 2 remote from angle. Hindwings trapezoidal-ovate, 5 bent and approximated to 4 at base.
Endemic.

98. *I. peroneanella* Walk., Cat. xxix, 658 ; Meyr., Trans. N.Z. Inst. 1883, 22 : *lichenella* Walk., Cat. xxix, 769 : (?) *adapertella* ibid. 653 : *huttonii* Butl., Cist. Ent. ii, 511 : *mystis* Meyr., Trans. N.Z. Inst. 1887, 79.
Auckland, Hamilton, Napier, Wellington, Nelson, Christchurch, Dunedin.

99. *I. picarella* Walk., Cat. xxix, 699 ; Meyr., Trans. N.Z. Inst. 1883, 23 : *teras* Feld., Reis. Nov. pl. cxl, 28.
Wellington, Dunedin, Invercargill.

100. *I. balanophora* Meyr., Trans. Ent. Soc. Lond. 1897, 389.
Wellington.

101. *I. apodoxa* Meyr., Trans. N.Z. Inst. 1887, 79.
Wellington.

102 *I. caustopa* Meyr., Trans. N.Z. Inst. 1891, 219.
Wellington.

103. *I. attactella* Walk., Cat. xxix, 787 ; *platyptera* Meyr., Trans. N.Z. Inst. 1887, 80.
Wellington. Larva under bark of *Elaeocarpus dentatus.*

104. *I. copiosella* Walk., Cat. xxx, 1028.
Ohakune.

105. *I. metadelta* Meyr., Trans. Ent. Soc. Lond. 1905, 238 ; *percnitis* Meyr., Trans. N.Z. Inst. 1908, 14.
Wellington.

106. *I. epiphanes* Meyr., Trans. N.Z. Inst. 1883, 24.
Wellington.

107. *I. prasophyta* Meyr., Trans. N.Z. Inst. 1883, 25.
Taranaki, Wellington.

108. *I. austera* Meyr., Trans. N.Z. Inst. 1883, 25.
Whangarei, Wellington.

109. *I. convulsella* Walk., Cat. xxix, 656 ; *paraneura* Meyr., Trans. N.Z. Inst. 1891, 219.
Wellington.

Group B. Eulechriades.

Antennae in ♂ regularly ciliated ; 7 of forewings to apex.

23. Trachypepla Meyr.

Trachypepla Meyr., Proc. Linn. Soc. N.S. Wales vii, 423 (1883) ; type, *euryleucota* Meyr. *Zirosaris* Meyr., Trans. N.Z. Inst. xlii, 66 (1910) ; type, *amorbas* Meyr.

Basal joint of antennae with pecten. Thorax crested or smooth. Forewings with tufts of scales. Hindwings elongate-ovate.

Besides the following, there are several Australian species.

110. *T. leucoplanetis* Meyr., Trans. N.Z. Inst. 1883, 14.
Auckland, Hamilton, Wellington, Mount Arthur (to 3,000 ft.), Otira River.

111. *T. euryleucota* Meyr., Trans. N.Z. Inst. 1883, 14.
Kaeo, Auckland, Cambridge, Wellington, Dunedin.

112. *T. conspicuella* Walk., Cat. xxix, 651 ; Meyr., Trans. N.Z. Inst. 1883, 15 : *taongella* Feld., Reis. Nov. pl. cxl, 45.
Wellington, Christchurch.

113. *T. amphileuca* Meyr., Trans. N.Z. Inst. 1913, 107.
Wainuiomata.

114. *T. hieropis* Meyr., Trans. N.Z. Inst. 1891, 218.
Wellington.

115. *T. galaxias* Meyr., Trans. N.Z. Inst. 1883, 17.
Whangarei, Hamilton, Wellington, Bealey River.

116. *T. spartodeta* Meyr., Trans. N.Z. Inst. 1883, 16.
Wellington.

117. *T. ingenua* Meyr., Trans. N.Z. Inst. 1910, 65.
Otira River.

118. *T. contritella* Walk., Cat. xxix, 657; *nyctopis* Meyr., Trans. N.Z. Inst. 1883, 16.
Auckland, Wellington, Nelson, Christchurch, Dunedin, Lake Wakatipu.

119. *T. protochlora* Meyr., Trans. N.Z. Inst. 1883, 18.
Palmerston, Wellington, Otira River, Invercargill.

120. *T. aspidephora* Meyr., Trans. N.Z. Inst. 1883, 19.
Wellington, Nelson, Mount Arthur (to 3,200 ft.), Christchurch, Dunedin.

121. *T. importuna* Meyr., Trans. N.Z. Inst. 1913, 108.
Wellington, Ohakune.

122. *T. vinaria* Meyr., Trans. N.Z. Inst. 1913, 108.
Greymouth, Otira River.

123. *T. lichenodes* Meyr., Trans. N.Z. Inst. 1883, 20; ibid. 1910, 66.
Wellington, Nelson, Otira River, Bealey River.

124. *T. anastrella* Meyr., Trans. N.Z. Inst. 1883, 19.
Wellington, Nelson, Otira River, Christchurch, Dunedin, Invercargill.

125. *T. amorbas* Meyr., Trans. N.Z. Inst. 1909, 66; ibid. 1910, 66.
Broken River, Lake Wakatipu.

126. *T. phaeoptila* Meyr., Trans. Ent. Soc. Lond. 1905, 236.
Mangaterere River.

127. *T. lathriopa* Meyr., Trans. Ent. Soc. Lond. 1905, 237.
Wellington, Nelson, Mount Arthur.

24. Atomotricha Meyr.

Atomotricha Meyr., Proc. Linn. Soc. N.S. Wales vii, 423 (1883); type, *ommatias* Meyr. *Brachysara* Meyr., Proc. Linn. Soc. N.S. Wales vii, 424 (1883); type, *sordida* Butl.

Antennae in ♂ with whorls of long cilia, basal joint with pecten. Thorax smooth. Forewings with small tufts of scales. Hindwings elongate-ovate. Wings in ♀ usually abbreviated or aborted.

Endemic.

128. *A. sordida* Butl., Proc. Zool. Soc. Lond. 1877, 405; Meyr., Trans. N.Z. Inst. 1883, 11; ibid. 1913, 110.
Christchurch.

129. *A. oeconoma* Meyr., Trans. N.Z. Inst. 1913, 110.
Wellington.

130. *A. versuta* Meyr., Trans. N.Z. Inst. 1913, 109.
Wellington.

131. *A. chloronota* Meyr., Trans. N.Z. Inst. 1913, 110.
Invercargill.

132. *A. ommatias* Meyr., Trans. N.Z. Inst. 1883, 10; ibid. 1913, 109.
Christchurch.

133. *A. exsomnis* Meyr., Trans N.Z. Inst. 1912, 26.
Ohakune.

134. *A. colligatella* Walk., Cat. xxix, 768.
North Island (?).

135. *A. isogama* Meyr., Trans. N.Z. Inst. 1908, 13; ibid. 1913, 109.
Wellington, Greymouth.

25. Barea Walk.

Barea Walk., Cat. xxix, 819 (1864); type, *consignatella* Walk.
Phloeopola Meyr., Proc. Linn. Soc. N.S. Wales vii, 423 (1883); type, *confusella* Walk.

Basal joint of antennae without pecten. Thorax with strong crest. Forewings without tufts. Hindwings elongate-ovate.

A considerable Australian genus. The larvae probably feed in bark of trees.

136. *B. dinocosma* Meyr., Proc. Linn. Soc. N.S. Wales 1883, 349; Trans. N.Z. Inst. 1883, 12.
Wellington.

137. *B. confusella* Walk., Cat. xxix, 682; Meyr., Proc. Linn. Soc. N.S. Wales 1883, 354.
Wellington, Levin. Probably a recent introduction from south-east Australia, where it is common, attached to *Eucalyptus*.

26. Eulechria Meyr.

Eulechria Meyr., Proc. Linn. Soc. N.S. Wales vii, 508 (1883); type, *exanimis* Meyr.

Basal joint of antennae with pecten. Thorax smooth. Forewings without tufts. Hindwings elongate-ovate.

A very large Australian genus.

138. *E. photinella* Meyr., Proc. Linn. Soc. N.S. Wales 1882, 541; Trans. N.Z. Inst. 1883, 9.
Wellington, Mount Arthur (to 4,000 ft.), Otira River.

139. *E. zophoessa* Meyr., Proc. Linn. Soc. N.S. Wales 1882, 515; Trans. N.Z. Inst. 1883, 8.
Wellington.

Group C. Philobotides.

Antennae in ♂ regularly ciliated; 7 of forewings to termen.

27. Oxythecta Meyr.

Oxythecta Meyr., Proc. Linn. Soc. N.S. Wales vii, 422 (1883); type, *acceptella* Walk.

Basal joint of antennae with pecten. Second joint of labial palpi expanded, with scales beneath on posterior half and rough towards apex, terminal joint as long as second. Hindwings elongate-ovate or ovate-lanceolate.

An Australian genus of a few species.

140. *O. austrina* Meyr., Trans. N.Z. Inst. 1913, 107.
Ben Lomond.

28. Philobota Meyr.

Philobota Meyr., Proc. Linn. Soc. N.S. Wales vii, 422 (1883); type, *arabella*, Newm.

Basal joint of antennae with pecten. Second joint of labial palpi with appressed scales, somewhat loose towards apex beneath, terminal joint shorter than second. Hindwings elongate-ovate.

A very large Australian genus, already including about 250 species.

141. *P. aletis* Meyr., Trans. Ent. Soc. Lond. 1905, 235.
Arthur's Pass.

142. *P. amenena* Meyr., Trans. N.Z. Inst. 1887, 78.
Arthur's Pass (4,700 ft.), Mount Arthur (4,000 ft.).

Group D. Depressariades.

Antennae in ♂ simple or shortly and irregularly ciliated.

29. Nymphostola Meyr.

Nymphostola Meyr., Proc. Linn. Soc. N.S. Wales vii, 491 (1883); type, *galactina* Feld.

Basal joint of antennae without pecten. Second joint of labial palpi with short triangular tuft of scales at apex beneath. Forewings with 7 to apex. Hindwings ovate, 5 bent and approximated to 4 at base.

Endemic.

143. *N. galactina* Feld., Reis. Nov. pl. cxl, 34; Meyr., Trans. N.Z. Inst. 1883, 6.
Hamilton, Wellington, Greymouth, Otira River, Dunedin. Larva on *Myrtus*.

30. Proteodes Meyr.

Proteodes Meyr., Proc. Linn. Soc. N.S. Wales vii, 492 (1883); type, *carnifex* Butl.

Basal joint of antennae without pecten. Second joint of labial palpi with appressed scales, somewhat rough beneath. Forewings with 7 to apex. Hindwings ovate, 5 bent and approximated to 4 at base.

Endemic.

144. *P. carnifex* Butl., Proc. Zool. Soc. Lond. 1877, 406; Meyr., Trans. N.Z. Inst. 1883, 7: *rufosparsa* Butl., Proc. Zool. Soc. Lond. 1877, 406.
Christchurch, Mount Hutt, Castle Hill, Arthur's Pass, Lake Wakatipu. Larva on *Fagus solandri* and probably other trees or shrubs.

145. *P. profunda* Meyr., Trans. Ent. Soc. Lond. 1905, 236.
Mount Holdsworth (2,000 ft.).

31. Lathicrossa Meyr.

Lathicrossa Meyr., Trans. N.Z. Inst. xvi, 26 (1884); type, *leucocentra* Meyr.

Basal joint of antennae without pecten. Second joint of labial palpi thickened with appressed scales. Thorax crested. Forewings with 7 to costa. Hindwings trapezoidal-ovate.

Endemic.

146. *L. leucocentra* Meyr., Trans. N.Z. Inst. 1883, 26.
Whangarei, Auckland, Wellington, Dunedin.

32. Cryptolechia Zell.

Cryptolechia Zell., Lep. Micr. Caffr. 106 (1852); type, *straminella* Zell. *Phaeosaces* Meyr., Trans. N.Z. Inst. xviii, 171 (1886); type, *apocrypta* Meyr. *Leptosaces* Meyr., Trans. N.Z. Inst. xx, 77 (1888); type, *callixyla* Meyr.

Basal joint of antennae without pecten. Second joint of labial palpi with appressed scales. Thorax smooth. Forewings with 7 to costa or apex. Hindwings trapezoidal-ovate.

A considerable genus of wide distribution.

147. *C. callixyla* Meyr., Trans. N.Z. Inst. 1887, 78.
Whangarei, Nelson.

148. *C. semnodes* Meyr., Trans. N.Z. Inst. 1910, 75.
Mount Arthur (4,200 ft.).

149. *C. apocrypta* Meyr., Trans. N.Z. Inst. 1885, 172.
Christchurch, Dunedin, Lake Wakatipu, Invercargill.

150. *C. liochroa* Meyr., Trans. N.Z. Inst. 1890, 98.
Wellington, Otira River, Lake Wakatipu, Invercargill.

151. *C. compsotypa* Meyr., Trans. N.Z. Inst. 1885, 172.
Whangarei, Auckland, Hamilton.

33. Symmoca Hüb.

Symmoca Hüb., Verz. 403 (1826); type, *signella* Hüb. *Oegoconia* Staint., Ins. Brit. Tin. 163 (1854); type, *quadripuncta* Haw.

Basal joint of antennae without pecten. Second joint of labial palpi with appressed scales. Thorax smooth. Forewings with 7 to costa. Hindwings elongate-ovate, 6 and 7 stalked.

A genus of some extent, chiefly European. The following species must be an accidental introduction.

152. *S. quadripuncta* Haw., Lep. Brit. 557; Meyr., Handb. Brit. Lep. 611.
Nelson. Widely distributed in Europe, attached to neighbourhood of houses, but larval habits not known.

34. Eutorna Meyr.

Eutorna Meyr., Trans. N.Z. Inst. xxi, 157 (1889); type, *caryochroa* Meyr.

Basal joint of antennae without pecten. Second joint of labial palpi thickened with dense appressed scales. Thorax smooth. Forewings with 6 to apex. Hindwings elongate-ovate; 3 and 4 separate, 5 bent.

Contains about a dozen Australian species and one Indian.

153. *E. caryochroa* Meyr., Trans. N.Z. Inst. 1888, 158.
Castle Hill, Dunedin, Lake Wakatipu, Invercargill.

154. *E. symmorpha* Meyr., Trans. N.Z. Inst. 1888, 158.
Whangarei, Hamilton, Palmerston, Napier, Christchurch, Dunedin, Invercargill.

6. XYLORYCTIDAE.

Head with loosely appressed scales. Labial palpi long, recurved, acute. Maxillary palpi very short, appressed. Forewings with 2 remote from angle, 7 and 8 stalked or separate. Hindwings broadly trapezoidal, apex obtuse, termen faintly sinuate; 3 and 4 connate, 5 rather approximated, 6 and 7 approximated or stalked.

A large family, chiefly found in the Southern Hemisphere and Indian regions; most numerous in South America.

35. Scieropepla Meyr.

Scieropepla Meyr., Trans. N.Z. Inst. xviii, 165 (1886); type, *typhicola* Meyr.

Forewings with 7 and 8 stalked, 7 to costa.

A small Australian genus.

155. *S. typhicola* Meyr., Trans. N.Z. Inst. 1885, 165.
Christchurch; also occurs in south-east Australia, which is probably its home. Larva in seed-heads and stems of *Typha*.

36. Agriophara Ros.

Agriophara Ros., Ann. Mag. Nat. Hist. (5) xvi, 439 (1885); type, *cinerosa* Ros. *Hypeuryntis* Meyr., Trans. Ent. Soc. Lond. 1897, 389; type, *coricopa* Meyr.

Forewings with 7 and 8 separate, 7 to apex.

Includes a moderate number of Australian and Indian species.

156. *A. coricopa* Meyr., Trans. Ent. Soc. Lond. 1897, 389.
Wellington, Greymouth.

7. HELIODINIDAE.

Head smooth. Basal joint of antennae without pecten. Labial palpi long, recurved, slender, acute. Maxillary palpi rudimentary or obsolete. Posterior legs raised from surface in repose, tarsi with whorls of bristles at apex of basal joints. Forewings with 7 and 8 separate or stalked. Hindwings lanceolate, 2–5 remote.

A considerable family, chiefly tropical.

37. Calicotis Meyr.

Calicotis Meyr., Trans. N.Z. Inst. xxi, 170 (1889); type, *crucifera* Meyr.

Basal joint of antennae dilated to form an eye-cap. Hindwings with 4 absent.

Also occurs in Australia and the Seychelles (probably the Malayan region).

157. *C. crucifera* Meyr., Trans. N.Z. Inst. 1888, 170.
Taranaki, Palmerston; occurs also in eastern Australia. Larva in fructification of staghorn fern (*Platycerium*).

38. Vanicela Walk.

Vanicela Walk., Cat. xxx, 1039 (1864); type, *disjunctella* Walk.

Antennae in ♂ with long ciliations, basal joint dilated to form an eye-cap. Anterior legs thickened with scales. Hindwings with 4 present.

There are three other species in eastern Australia.

158. *V. disjunctella* Walk., Cat. xxx, 1039; Meyr., Trans. N.Z. Inst. 1888, 166.
Whangarei, Auckland, Taranaki, Palmerston, Masterton, Wellington, Nelson.

39. Stathmopoda Staint.

Stathmopoda Staint., Ins. Brit. Tin. 227 (1854); type, *pedella* Linn.
Boocara Butl., Cist. Ent. ii, 562 (1880); type, *skelloni* Butl.

Antennae in ♂ with long ciliations. Hindwings with 4 present.

A large genus, especially characteristic of the Indian and Australian regions.

159. *S. caminora* Meyr., Trans. N.Z. Inst. 1889, 219.
Wellington.

160. *S. campylocha* Meyr., Trans. N.Z. Inst. 1888, 168.
Wellington, Dunedin.

161. *S. holochra* Meyr., Trans. N.Z. Inst. 1888, 168.
Wellington.

162. *S. fusilis* Meyr., Trans. N.Z. Inst. 1913, 111.
Wellington.

163. *S. phlegyra* Meyr., Trans. N.Z. Inst. 1888, 168.
Kaeo, Auckland, Taranaki, Palmerston, Wanganui, Wellington.

164. *S. skelloni* Butl., Cist. Ent. ii, 562; Meyr., Trans. N.Z. Inst. 1888, 169.
Taranaki, Palmerston, Wellington, Blenheim, Nelson, Christchurch, Dunedin, Lake Wakatipu, Invercargill.

165. *S. aposema* Meyr., Trans. Ent. Soc. Lond. 1901, 575.
Auckland.

166. *S. plumbiflua* Meyr., Trans. N.Z. Inst. 1910, 75.
Invercargill.

167. *S. mysteriastis* Meyr., Trans. Ent. Soc. Lond. 1901, 575.
Auckland, Wellington.

40. Pachyrhabda Meyr.

Pachyrhabda Meyr., Proc. Linn. Soc. N.S. Wales xxii, 312 (1897); type, *steropodes* Meyr.

Antennae in ♂ stout, simple. Hindwings with 4 absent.

Includes a few species from India, Australia and Africa.

168. *P. epichlora* Meyr., Trans. N.Z. Inst. 1888, 169.
Auckland, Wellington, Otira River.

169. *P. antinoma* Meyr., Trans. N.Z. Inst. 1909, 72.
Kermadec Islands. This widely distributed species, which ranges from India to eastern Australia, may perhaps occur in the North Island.

41. Thylacosceles Meyr.

Thylacosceles Meyr., Trans. N.Z. Inst. xxi, 171 (1889); type, *acridomima* Meyr.

Antennae in ♂ stout, simple. Posterior tibiae with triangular tuft of scales on posterior half. Hindwings with 4 present.

Besides the following there are two species from Ceylon.

170. *T. acridomima* Meyr., Trans. N.Z. Inst. 1888, 171.
Wellington.

8. AEGERIADAE.

Head with appressed scales. Antennae dilated on apical half. Labial palpi moderately long, curved, ascending, terminal joint short, pointed. Maxillary palpi rudimentary. Forewings with 7 and 8 stalked. Hindwings elongate-ovate, 5 absent, 6 and 7 nearly parallel, 8 concealed in rolled costa.

A rather considerable family, principally inhabiting the Northern Hemisphere.

42. Trochilium Scop.

Authorities disagree as to the proper name for this genus; many use *Sesia* Fab., but, as this is employed by others in quite a different sense, it seems better to use the name *Trochilium* as less liable to misinterpretation.

171. *T. tipuliforme* Clerck, Icon. pl. ix, 1; Meyr., Trans. N.Z. Inst. 1889, 214.
Nelson, Christchurch, Dunedin; introduced artificially from Europe. Larva in stems of garden currant (*Ribes*).

9. GLYPHIPTERYGIDAE.

Head with appressed scales. Basal joint of antennae without pecten. Labial palpi moderate, curved, ascending, terminal joint compressed, pointed or obtuse. Maxillary palpi rudimentary. Forewings with 7 and 8 separate or stalked. Hindwings ovate or elongate-ovate; 3 and 4 connate, 5-7 somewhat approximated towards base or nearly parallel.

A considerable family, more especially characteristic of the equatorial region and Southern Hemisphere, except Africa.

43. Coridomorpha Meyr.

Coridomorpha Meyr., Trans. N.Z. Inst. xlvi, 111 (1914); type, *stella* Meyr.

Basal half of antennae thickened with dense scales. Labial palpi long, second joint with appressed scales, terminal joint shorter, acute. Forewings with 7 and 8 stalked, 7 to costa.

Endemic.

172. *C. stella* Meyr., Trans. N.Z. Inst. 1913, 111.
Auckland, Wellington.

44. Hierodoris Meyr.

Hierodoris Meyr., Exot. Micr. i, 41 (1912); type, *iophanes* Meyr.

Labial palpi with appressed scales, terminal joint shorter than second, pointed. Forewings with 7 absent.

Endemic.

173. *H. iophanes* Meyr., Exot. Micr. i, 42; Trans. N.Z. Inst. 1912, 27.
Wellington.

45. Heliostibes Zell.

Heliostibes Zell., Verh. Zool.-bot. Ges. Wien xxiv, 434 (1874); type, *mathewi* Zell.

Labial palpi with appressed scales, terminal joint shorter than second, acute. Forewings with 7 and 8 stalked, 7 to apex.

Besides the following only one Chilian species is known.

174. *H. callispora* Meyr., Exot. Micr. i, 41; Trans. N.Z. Inst. 1912, 27.
Wellington.

175. *H. electrica* Meyr., Trans. N.Z. Inst. 1888, 157.
Nelson, Mount Arthur (4,700 ft.), Invercargill, Lake Tekapo.

176. *H. atychioides* Butl., Proc. Zool. Soc. Lond. 1877, 405, pl. xliii, 14; Meyr., Trans. N.Z. Inst. 1887, 83.
Whangarei, Hamilton, Wellington, Christchurch.

177. *H. illita* Feld., Reis. Nov. pl. cxl, 32; Meyr., Trans. N.Z. Inst. 1887, 83.
Nelson, Dunedin.

46. Simaethis Leach.

Simaethis Leach, Edin. Encycl. ix, 135 (1815); type, *fabriciana* Linn.

Labial palpi with second joint more or less roughly scaled, terminal joint shorter, thickened with scales, obtuse. Forewings with 7 to termen.

A considerable genus, most numerous within the tropics.

178. *S. exocha* Meyr., Trans. N.Z. Inst. 1906, 121.
Lake Wakatipu.

179. *S. zomeuta* Meyr., Trans. N.Z. Inst. 1911, 121.
Mount Arthur (4,600 ft.).

180. *S. combinatana* Walk., Cat. xxviii, 456; Meyr., Proc. Linn. Soc. N.S. Wales 1880, 213; Huds., Ent. M. Mag. 1890, 22: *abstitella* Walk., Cat. xxx, 997.
Wellington. Larva on *Senecio bellidioides*.

181. *S. colpota* Meyr., Trans. N.Z. Inst. 1910, 67.
Invercargill.

182. *S. iochondra* Meyr., Trans. N.Z. Inst. 1910, 77.
Mount Holdsworth (3,000 ft.).

183. *S. symbolaea* Meyr., Trans. N.Z. Inst. 1887, 85.
Arthur's Pass.

184. *S. ministra* Meyr., Trans. N.Z. Inst. 1911, 121.
Mount Holdsworth.

185. *S. marmarea* Meyr., Trans. N.Z. Inst. 1887, 85.
Lake Wakatipu.

186. *S. analoga* Meyr., Trans. N.Z. Inst. 1911, 122.
Mount Arthur (4,000 ft.).

187. *S. microlitha* Meyr., Trans. N.Z. Inst. 1887, 84; ibid. 1911, 122.
Castle Hill, Arthur's Pass.

188. *S. antigrapha* Meyr., Trans. N.Z. Inst. 1910, 76.
Wellington.

189. *S. barbigera* Meyr., Trans. N.Z. Inst. 1914, 203.
Hunter Mountains.

47. Choreutis Hüb.

Choreutis Hüb., Verz. 373 (1826); type, *myllerana* Fab.

Labial palpi with second joint roughly tufted, terminal joint slender, pointed. Forewings with 7 to termen.

Chiefly American and Indo-Malayan, ranging into Australia and Europe.

190. *C. bjerkandrella* Thunb., Diss. Ent. i, 36, pl. iii, 23, 24; Meyr., Proc. Linn. Soc. N.S. Wales 1880, 215.

Kaeo, Whangarei, Hamilton, Taranaki, Palmerston, Napier, Nelson. A cosmopolitan species. Larva on thistle (*Carduus*) and other *Compositae*.

48. Pantosperma Meyr.

Pantosperma Meyr., Trans. N.Z. Inst. xx, 89 (1888); type, *holochalca* Meyr.

Antennae almost as long as forewings. Labial palpi with appressed scales, slightly rough anteriorly, terminal joint as long as second, pointed. Forewings with 7 and 8 stalked, 7 to termen. Hindwings lanceolate.

Endemic.

191. *P. holochalca* Meyr., Trans. N.Z. Inst. 1887, 89.
Makatoku, Wellington.

49. Glyphipteryx Hüb.

Glyphipteryx Hüb., Verz. 421 (1826); type, *thrasonella* Scop. *Phryganostola* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 248; type, *drosophaes* Meyr. *Circica* Meyr., Trans. N.Z. Inst. xx, 88 (1888); type, *cionophora* Meyr.

Labial palpi with second joint loosely or roughly scaled in whorls, sometimes tufted, terminal joint compressed, roughened, pointed. Forewings with 7 to termen, 7 and 8 sometimes stalked.

A large cosmopolitan genus, but especially well represented in Australia and New Zealand, very scantily in Europe, Africa, and North America.

192. *G. cionophora* Meyr., Trans. N.Z. Inst. 1887, 88.
Christchurch, Dunedin.

193. *G. xestobela* Meyr., Trans. N.Z. Inst. 1887, 89.
Arthur's Pass.

194. *G. rugata* Meyr., Trans. N.Z Inst. 1914,
Tisbury.

195. *G. ataracta* Meyr., Trans. N.Z. Inst. 1887, 88.
Mount Arthur (4,600 ft.).

196. *G. achlyoessa* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 252.
Auckland, Wellington, Invercargill.

197. *G. bactrias* Meyr., Trans. N.Z. Inst. 1910, 67.
Invercargill.

198. *G. metasticta* Meyr., Trans. N.Z. Inst. 1906, 120.
Invercargill.

199. *G. aulogramma* Meyr., Trans. N.Z. Inst. 1907, 121.
Invercargill.

200. *G. codonias* Meyr., Trans. N.Z. Inst. 1908, 15.
Invercargill.

201. *G. transversella* Walk., Cat. xxx, 849; Meyr., Proc. Linn. Soc. N.S Wales 1880, 246: (?) *morangella* Feld., Reis. Nov. pl. cxl, 39.
Auckland, Napier.

202. *G. astrapaea* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 245.
Cambridge, Christchurch, Mount Arthur (to 4,500 ft.), Bealey River, Invercargill.

203. *G. aerifera* Meyr., Exot. Micr. i, 57; Trans. N.Z. Inst. 1912, 28.
Mount Ruapehu (4,500 ft.).

204. *G. oxymachaera* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 251.
Auckland, Wellington, Christchurch, Castle Hill, Lake Wakatipu (to 4,000 ft.), Invercargill.

205. *G. scolias* Meyr., Trans. N.Z. Inst. 1909, 73.
Kermadec Islands.

206. *G. calliactis* Meyr., Trans. N.Z. Inst. 1913, 112.
Kaitoke. Larva in flower-stems of *Gahnia.*

207. *G. iocheaera* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 243.
Auckland, Wellington, Christchurch, Castle Hill, Dunedin, Lake Wakatipu, Invercargill. Larva on *Juncus.*

208. *G. leptosema* Meyr., Trans. N.Z. Inst. 1887, 87; ibid. 1910, 75.
Auckland, Wellington. Larva in flower-stems of *Gahnia setifolia.*

209. *G. dichorda* Meyr., Trans. N.Z. Inst. 1910, 76.
Whangarei, Wellington.

210. *G. asteronota* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 240; (?) *tungella* Feld., Reis. Nov. pl. cxl, 40.
Whangarei, Auckland, Napier.

211. *G. euastera* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 236.
Christchurch.

212. *G. acrothecta* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 244.
Christchurch, Castle Hill.

213. *G. nephoptera* Meyr., Trans. N.Z. Inst. 1887, 87.
Christchurch.

214. *G. zelota* Meyr., Trans. N.Z. Inst. 1887, 86.
Whangarei, Waitakere Range.

215. *G. acronoma* Meyr., Trans. N.Z. Inst. 1887, 86.
Mount Arthur (4,000 ft.).

216. *G. erastis* Meyr., Trans. N.Z. Inst. 1910, 76.
Christchurch, Castle Hill, Lake Wakatipu.

217. *G. triselena* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 234; ibid. 1882, 188.
Christchurch, Lake Wakatipu, Invercargill.

10. Hyponomeutidae.

Head with appressed scales or rough on crown. Labial palpi moderate, ascending, rather pointed. Maxillary palpi rudimentary or obsolete. Fore-

wings with costal stigmatium between 11 and 12, 7 and 8 separate or stalked, 7 to termen. Hindwings elongate-ovate or lanceolate; 4 absent.

A considerable family, generally distributed, but almost absent from New Zealand.

50. Zelleria Staint.

Zelleria Staint., Cat. Brit. Tin. 22 (1849); type, *hepariella* Staint. *Hofmannia* Wocke, Hein. Schmett. Deutsch. ii (2), 644 (1877); type, *saxifragae* Staint. *Circostola* Meyr., Trans. N.Z. Inst. xxi, 163 (1889); type, *copidota* Meyr.

Head rough on crown. Hindwings lanceolate.

Of moderate extent and generally distributed.

218. *Z. copidota* Meyr., Trans. N.Z. Inst. 1888, 163.
Wellington, Nelson, Otira River, Lake Wakatipu.

219. *Z. sphenota* Meyr., Trans. N.Z. Inst. 1888, 162.
Christchurch.

51. Hyponomeuta Latr.

Hyponomeuta Latr., Gen. Crust. Ins. iv, 222 (1796).

Head with appressed scales. Hindwings elongate-ovate.

Includes about fifty species, generally distributed.

220. *H. cuprea* Meyr., Trans. Ent. Soc. Lond. 1901, 575.
Wellington, Lake Wakatipu.

11. Gracilariadae.

Head with appressed scales. Antennae 1 or over 1. Labial palpi slender, ascending, tolerably pointed. Maxillary palpi moderate, filiform, porrected. Forewings with 7 and 8 stalked or separate. Hindwings lanceolate or linear.

An extensive family of general distribution.

52. Acrocercops Wall.

Acrocercops Wall., Ent. Tidskr. ii, 95 (1881); type, *brongniardella* Fab. *Conopomorpha* Meyr., Trans. N.Z. Inst. xviii, 183 (1886); type, *cyanospila* Meyr.

Middle tibiae not thickened; posterior tibiae with series of projecting bristly scales above.

A large genus, principally developed in the Indo-Australian region. The larvae usually mine blotches in leaves.

221. *A. cyanospila* Meyr., Trans. N.Z. Inst. 1885, 183.
Taranaki, Palmerston, Masterton, Makatoku, Wellington.

53. Parectopa Clem.

Parectopa Clem., Proc. Acad. Nat. Sc. Philad. 1860, 210; type, *lespedezifoliella* Clem.

Middle tibiae not thickened; posterior tibiae without bristly scales.

Of considerable extent and generally distributed.

222. *P. aethalota* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 143; Trans. N.Z. Inst. 1888, 185.
Dunedin.

223. *P. leucocyma* Meyr., Trans. N.Z. Inst. 1888, 184.
Auckland.

224. *P. aellomacha* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 158.
Wellington, Christchurch.

225. *P. miniella* Feld., Reis. Nov. pl. cxl, 42; Meyr., Trans. N.Z. Inst. 1888, 185; Gen. Ins. 128, f. 3; *ethela* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 152.
Kaeo, Waitakere Ranges, Hamilton, Palmerston, Taranaki, Wellington.

54. Gracilaria Haw.

Gracilaria Haw., Lep. Brit. 527 (1828); type, *syringella* Fab.

Middle tibiae thickened with dense scales; posterior tibiae without bristly scales.

A large genus, universally distributed.

226. *G. octopunctata* Turn., Trans. Roy. Soc. S. Austr. 1894, 123.
Kermadec Islands; also in India, Australia, and Africa. Larva on *Dalbergia sissu.*

227. *G. linearis* Butl., Proc. Zool. Soc. Lond. 1877, 406; Meyr., Trans. N.Z. Inst. 1888, 183; ibid. 1910, 67.
Napier, Wellington, Christchurch, Arthur's Pass, Invercargill.

228. *G. elaeas* Meyr., Trans. N.Z. Inst. 1910, 66.
Castle Hill. Larva on *Coriaria.*

229. *G. selenitis* Meyr., Trans. N.Z. Inst. 1908, 15.
Mount Holdsworth (3,000 ft.).

230 *G. chrysitis* Feld., Reis. Nov. pl. cxl, 43; Meyr., Trans. N.Z. Inst. 1888, 183: *adelina* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 142: *rutilans* Butl., Cist. Ent. ii, 561.
Kaeo, Hamilton, Palmerston, Wellington, Christchurch.

231. *G. chalcodelta* Meyr., Trans. N.Z. Inst. 1888, 183.
Whangarei, Auckland, Taranaki, Masterton, Makatoku, Wellington.

12. Coleophoridae.

Head with appressed scales. Labial palpi bent, ascending, pointed, with scales of second joint somewhat angularly projecting beneath at apex. Maxillary palpi rudimentary. Forewings with 5 absent, 7 to costa, 8 absent. Hindwings linear-lanceolate.

A considerable family of wide distribution.

55. Batrachedra Staint.

Batrachedra Staint., Ins. Brit. Tin. 230 (1854); type, *praeangusta* Haw.

A genus of some extent, principally Indo-Australian.

232. *B. psithyra* Meyr., Trans. N.Z. Inst. 1888, 181.
Auckland, Hamilton, Wellington, Nelson, Invercargill.

233. *B. tristicta* Meyr., Trans. Ent. Soc. Lond. 1901, 579.
Makatoku.

234. *B. arenosella* Walk., Cat. xxx, 857; Meyr., Trans. N.Z. Inst. 1888, 181.
Palmerston, Wellington, Christchurch; also common and widely distributed in Australia. Larva on seeds of *Juncus*.

235. *B. eucola* Meyr., Trans. N.Z. Inst. 1888, 180.
Bealey River.

236. *B. agaura* Meyr., Trans. Ent. Soc. Lond. 1901, 579.
Whangarei, Wellington, Nelson, Mount Arthur, Invercargill.

13. PLUTELLIDAE.

Head usually with appressed scales. Labial palpi bent, ascending, pointed, terminal joint as long as second or longer. Maxillary palpi rather short, filiform, porrected. Forewings with 7 and 8 separate or stalked. Hindwings trapezoidal-ovate or elongate-ovate.

A small family of considerable antiquity.

56. Dolichernis Meyr.

Dolichernis Meyr., Trans. N.Z. Inst. xxiii, 99 (1891); type, *chloroleuca Meyr.*

Head rough on crown. Antennae over 1, basal joint with pecten. Forewings with 4 absent. Hindwings with 3 and 4 connate.

Endemic.

237. *D. chloroleuca* Meyr., Trans. N.Z. Inst. 1890, 99.
Wellington.

57. Doxophyrtis Meyr.

Doxophyrtis Meyr., Trans. N.Z. Inst. xlvi, 112 (1914); type, *hydrocosma* Meyr.

Basal joint of antennae without pecten. Hindwings with 3 and 4 connate.

Endemic.

238. *D. hydrocosma* Meyr., Trans. N.Z. Inst. 1913, 113.
Kaeo, Waitakere Ranges.

58. Protosynaema Meyr.

Protosynaema Meyr., Trans. N.Z. Inst. xviii, 173 (1886); type, *eratopis* Meyr.

Antennae thickened with scales towards base, basal joint without pecten. Forewings with 7 and 8 separate. Hindwings with 3 and 4 remote.

Endemic.

239. *P. steropucha* Meyr., Trans. N.Z. Inst. 1885, 174; ibid. 1913, 112.
Hamilton, Wellington, Christchurch.

240. *P. eratopis* Meyr., Trans. N.Z. Inst. 1885, 174.
Mount Arthur, Otira River.

59. Phylacodes Meyr.

Phylacodes Meyr., Trans. Ent. Soc. Lond. 1905, 241; type, *cauta* Meyr.

Antennae thickened with scales on basal half, basal joint without pecten. Forewings with 7 and 8 stalked. Hindwings with 3 and 4 rather approximated.

Endemic.

241. *P. cauta* Meyr., Trans. Ent. Soc. Lond. 1905, 242.
Dunedin.

60. Orthenches Meyr.

Orthenches Meyr., Trans. N.Z. Inst. xviii, 175 (1886); type, *chlorocoma* Meyr.

Basal joint of antennae with pecten. Forewings with 7 and 8 separate. Hindwings with 3 and 4 remote.

Besides the following there are at present known only one Australian and one Indian species.

242. *O. saleuta* Meyr., Trans. N.Z. Inst. 1912, 28.
Waiouru.

243. *O. drosochaloa* Meyr., Trans. Ent. Soc. Lond. 1905, 242.
Wellington, Otira River.

244. *O. porphyritis* Meyr., Trans. N.Z. Inst. 1885, 176.
Otira River, Dunedin, Invercargill. Larva on *Podocarpus totara.*

245. *O. chlorocoma* Meyr., Trans. N.Z. Inst. 1885, 175.
Christchurch. Larva on *Carmichaelia australis.*

246. *O. prasinodes* Meyr., Trans. N.Z. Inst. 1885, 176.
Christchurch, Wainuiomata, Greymouth.

61. Plutella Schranck.

Plutella Schranck, Faun. Boic. ii, 169 (1802); type, *porrectella* Linn.

Basal joint of antennae with dense pecten. Labial palpi with second joint tufted beneath. Forewings with 7 and 8 separate. Hindwings with 3 and 4 connate or somewhat approximated.

A small cosmopolitan genus.

247. *P. megalynta* Meyr., Trans. N.Z. Inst. 1914, 203.
Wellington.

248. *P. sera* Meyr., Trans. N.Z. Inst. 1885, 178.
Whangarei, Taranaki, Palmerston, Makatoku, Christchurch; also common in Australia and India. Probably artificially introduced.

249. *P. antiphona* Meyr., Trans. Ent. Soc. Lond. 1901, 576.
Wellington.

250. *P. psammochroa* Meyr., Trans. N.Z. Inst. 1885, 179.
Otira River; also occurs in Australia.

251. *P. maculipennis* Curt., Brit. Ent. pl. 420; *cruciferarum* Zell., Meyr. Trans. N.Z. Inst. 1885, 177.
Cambridge, Taranaki, Wellington, Nelson, Christchurch, Bealey River, Lake Wakatipu, doubtless universal; Kermadec Islands. Occurs throughout the world, being the most cosmopolitan of the *Lepidoptera*. Larva on cabbage, turnip, and other *Cruciferae.*

14. NEPTICULIDAE.

Head roughly tufted. Basal joint of antennae forming an eye-cap. Labial palpi short, drooping. Maxillary palpi long, folded. Forewings with cell open, 3–5 absent, 9 absent. Hindwings lanceolate, cell open, 3–5 absent; frenulum multiple in both sexes.

These minute insects are so generally overlooked that their distribution is little known, but they occur in all regions.

62. Nepticula Heyd.

Nepticula Heyd., Ber. Ver. Nat. Mainz. 1842, 201.

252. *N. ogygia* Meyr., Trans. N.Z. Inst. 1888, 187.
Dunedin.

253. *N. tricentra* Meyr., Trans. N.Z. Inst. 1888, 187.
Christchurch.

254. *N. propalaea* Meyr., Trans. N.Z. Inst. 1888, 187.
Arthur's Pass.

15. LYONETIADAE.

Head usually tufted on crown, sometimes smooth. Antennae with basal joint often forming an eye-cap. Labial palpi porrected or subascending, more or less obtuse. Maxillary palpi usually long, folded. Forewings with apex bent up or down. Hindwings lanceolate or ovate-lanceolate.

A considerable family, generally distributed.

63. Bedellia Staint.

Bedellia Staint., Cat. Brit. Tin. 23 (1849); type, *somnulentella* Zell.

Head rough on crown, face smooth. Basal joint of antennae rather stout, with large dense pecten. Labial palpi short, porrected. Maxillary palpi rudimentary. Forewings with 4 and 5 absent. Hindwings linear-lanceolate; 3 and 4 absent.

A small genus of scattered species.

255. *B. somnulentella* Zell., Isis 1847, 894: Meyr., Trans. N.Z. Inst. 1888, 164.
Dunedin. Nearly cosmopolitan in suitable localities, but probably artificially introduced. Larva mining in leaves of *Convolvulus* and *Ipomoea*.

256. *B. psamminella* Meyr., Trans. N.Z. Inst. 1888, 165.
Taranaki, Christchurch, Dunedin.

64. Cateristis Meyr.

Cateristis Meyr., Trans. N.Z. Inst. xxi, 163 (1889); type, *eustyla* Meyr.

Head rough on crown, face smooth. Basal joint of antennae enlarged, with dense pecten forming an eye-cap. Labial palpi short, drooping.

Maxillary palpi rudimentary. Forewings with 3 and 4 absent, 9 absent. Hindwings lanceolate; 3 and 4 absent.

Contains only the following species.

257. *C. eustyla* Meyr., Trans. N.Z. Inst. 1888, 164.
Christchurch; also occurs in Tasmania.

65. Opogona Zell.

Opogona Zell., Bull. Soc. Nat. Mosc. xxvi, 507 (1853); type, *dimidiatella* Zell. *Lozostoma* Staint., Trans. Ent. Soc. Lond. (2) v, 124 (1860); type, *flavofasciata* Staint.

Head smooth, with raised fillet between antennae. Basal joint of antennae very long, flattened, concave beneath. Labial palpi moderately long, porrected, diverging. Maxillary palpi long, folded. Forewings with 6–8 stalked. Hindwings lanceolate.

A considerable genus, widely distributed in warm regions. The larvae feed on dry vegetable matter.

258. *O. comptella* Walk., Cat. xxx, 1007; Meyr., Proc. Linn. Soc. N.S. Wales 1897, 416.
Nelson. Common in south-east Australia, whence it must have been accidentally introduced.

259. *O. aurisquamosa* Butl., Ann. Mag. Nat. Hist. (5) vii, 403.
Kermadec Islands; also in Hawaiian, Marquesas, and Society Islands. Bred from sugar-cane, &c.

66. Hieroxestis Meyr.

Hieroxestis Meyr., Proc. Linn. Soc. N.S. Wales 1892, 567; type, *omoscopa* Meyr. *Amphixystis* Meyr., Trans. Ent. Soc. Lond. 1901, 576; type, *hapsimacha* Meyr.

Head smooth, with raised fillet between antennae and tuft of hairs behind it. Basal joint of antennae very long, flattened, concave beneath. Labial palpi moderately long, subascending, diverging. Maxillary palpi long, folded. Forewings with 6–8 stalked. Hindwings lanceolate.

Attains some development in Indian and African regions.

260. *H. omoscopa* Meyr., Proc. Linn. Soc. N.S. Wales 1892, 567.
Kaeo, Waikino; also in Australia and South Africa, the latter country being apparently its home. Has been bred from cork, with which it is probably introduced.

261. *H. hapsimacha* Meyr., Trans. Ent. Soc. Lond. 1901, 577.
Kaeo, Wellington.

67. Eugennaea n.g.

Head rough. Basal joint of antennae somewhat dilated. Labial palpi moderately long, porrected, second joint with projecting scales beneath towards apex, terminal joint shorter than second, loosely scaled, somewhat pointed. Maxillary palpi long, folded, filiform. Posterior tibiae clothed with hairs. Forewings with 4 absent, 6 almost to apex, 7 absent. Hindwings elongate-ovate; 2–4 parallel, 5 and 6 stalked, 6 to termen, 7 parallel.

Endemic. Differs from *Decadarchis* by 6 of hindwings running to termen

. *E. laquearia* Meyr., Trans. N.Z. Inst. 1913, 113.
Kaeo, Porirua.

68. Erechthias Meyr.

Erechthias Meyr., Proc. Linn. Soc. N.S. Wales v, 261 (1880); type, *charadrota* Meyr.

Head rough. Basal joint of antennae moderate. Labial palpi moderately long, more or less loosely scaled. Maxillary palpi long, folded. Forewings with 4 absent, 7 separate or stalked with 8. Hindwings lanceolate or ovate-lanceolate; 5 and 6 stalked, 6 to costa.

A genus of some extent, most developed in the Indo-Malayan and Australian regions. I regret when restricting the genus *Erechthias* to have misapplied the name to the following genus, overlooking the fact that the neural characters originally assigned to it only agree with this one. For this genus I have hitherto used the name *Ereunetis*, but I now consider that *Ereunetis* (type *iuloptera* Meyr.) must be maintained as a distinct genus, characterized by having the cell of hindwings open between 3 and 4, and not represented in New Zealand. *Decadarchis* also does not occur in New Zealand.

263. *E. monastra* Meyr., Trans. N.Z. Inst. 1890, 100.
Wellington.

264. *E. externella* Walk., Cat. xxx, 841; *erebistis* Meyr., Trans. N.Z. Inst. 1891, 220.
Wellington.

265. *E. acrodina* Meyr., Trans. N.Z. Inst. 1911, 122.
Wellington.

266. *E. melanotricha* Meyr., Trans. N.Z. Inst. 1887, 93.
Whangarei, Auckland.

267. *E. terminella* Walk., Cat. xxviii, 548: *subpavonella* ibid. xxx, 898; Meyr., Proc. Linn. Soc. N.S. Wales 1880, 269.
Auckland, Taranaki.

268. *E. charadrota* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 268.
Auckland, Taranaki, Wellington, Christchurch.

269. *E. flavistriata* Wals., Faun. Haw. i, 716, pl. xxv, 18.
Kermadec Islands; also occurs in the Hawaiian Islands.

270. *E. exospila* Meyr., Trans. Ent. Soc. Lond. 1901, 577.
Whangarei, Kaeo.

271. *E. hemiclistra* Meyr., Trans. N.Z. Inst. 1910, 77.
Wellington, Makara, Invercargill. Larva in flower-stems of *Arundo conspicua*.

272. *E. fulguritella* Walk., Cat. xxviii, 548.
Wellington, Christchurch, Dunedin, Lake Wakatipu, Invercargill.

69. Hectacma n.g.

Head rough. Basal joint of antennae elongate. Labial palpi moderately long, terminal joint enlarged with scales projecting at apex, longer than

second. Maxillary palpi long, folded. Forewings with all veins present, 7 separate. Hindwings ovate-lanceolate; 5 and 6 stalked, 6 to apex or costa (*chionodira*).

Type *chasmatias* Meyr. Endemic.

273. *H. chionodira* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 268.
Auckland, Taranaki, Wellington.

274. *H. stilbella* Doubl., Dieff. N. Zeal. ii, 289; Walk., Cat. xxx, 849; Meyr., Proc. Linn. Soc. N.S. Wales 1880, 265.
Auckland, Taranaki, Wellington, Lower Hutt River.

275. *H. chasmatias* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 264.
Whangarei, Wellington.

70. Tephrosara n.g.

Head rough. Basal joint of antennae flattened, excavated beneath. Labial palpi moderately long, with rough projecting scales beneath throughout. Maxillary palpi long, folded. Forewings with all veins present, 7 and 8 stalked. Hindwings ovate-lanceolate; 5 and 6 stalked, 6 to termen.

Endemic.

276. *T. cimmeria* Meyr., Trans. N.Z. Inst. 1913, 113.
Waitakere Ranges.

71. Petasactis n.g.

Head rough. Basal joint of antennae flattened, excavated beneath. Labial palpi moderately long, second joint with projecting scales towards apex beneath. Maxillary palpi long, folded. Forewings with all veins present, 7 and 8 stalked. Hindwings ovate-lanceolate; 5 and 6 stalked, 6 to costa.

Endemic.

277. *P. technica* Meyr., Trans. N.Z. Inst. 1887, 92.
Whangarei.

72. Dryadaula Meyr.

Dryadaula Meyr., Proc. Linn. Soc. N.S. Wales xvii, 559 (1892); type, *glycinopa* Meyr.

Head rough. Basal joint of antennae moderate. Labial palpi moderately long. Maxillary palpi long, folded. Forewings with all veins present, 7 and 8 stalked. Hindwings ovate-lanceolate; 6 absent.

Besides the following there are several Australian species.

278. *D. myrrhina* Meyr., Trans. Ent. Soc. Lond. 1905, 243.
Kaeo, Kaitoke, Wellington.

279. *D. pactolia* Meyr., Trans. Ent. Soc. Lond. 1901, 577.
Wellington, Nelson, Bealey River.

73. Eschatotypa Meyr.

Eschatotypa Meyr., Proc. Linn. Soc. N.S. Wales v, 256 (1880); type, *melichrysa* Meyr.

Head rough. Basal joint of antennae moderate, excavated beneath. Labial palpi moderately long, second joint with projecting scales towards

apex beneath. Maxillary palpi long, folded. Forewings with all veins present, 7 separate. Hindwings ovate-lanceolate; 5 and 6 stalked, 6 to termen.

Endemic.

280. *E. melichrysa* Meyr., Proc. Linn. Soc. N.S. Wales 1880, 257; Trans. N.Z. Inst. 1908, 16.
Whangarei, Auckland, Kaeo, Nelson, Dunedin, Invercargill.

281. *E. derogatella* Walk., Cat. xxviii, 485.
Auckland, Masterton, Wellington, Christchurch, Invercargill.

16. TINEIDAE.

Head usually rough; tongue usually absent. Labial palpi porrected or subascending, more or less obtuse. Maxillary palpi often long, folded. Forewings with 7 usually to costa, separate. Hindwings elongate-ovate or lanceolate; 2–4 usually remote, parallel, 5 and 6 sometimes stalked, 7 separate.

A very large family of universal distribution, but relatively most numerous in Africa. The larvae usually feed on dead wood, lichens, refuse, &c.

74. Endophthora Meyr.

Endophthora Meyr., Trans. N.Z. Inst. xx, 93 (1888); type, *omogramma* Meyr.

Head rough. Maxillary palpi long, folded. Forewings with 2 and 3 connate from angle, 4 absent. Hindwings lanceolate; cell open between 3 and 4, 5 and 6 stalked.

Endemic, as now restricted.

282. *E. omogramma* Meyr., Trans. N.Z. Inst. 1887, 94.
Auckland, Wellington, Nelson, Mount Arthur.

75. Crypsitricha n.g.

Head rough. Basal joint of antennae rather dilated, with pecten. Labial palpi rather long, subascending, second joint with appressed scales, terminal joint shorter than second, slender. Maxillary palpi long, folded. Forewings with all veins present; on lower surface with fringe of short hairs on vein 1*b* in disc. Hindwings lanceolate.

Type, *mesotypa* Meyr. Besides the following there is one Australian species.

283. *C. stereota* Meyr., Trans. N.Z. Inst. 1913, 114.
Auckland.

284. *C. pharotoma* Meyr., Trans. N.Z. Inst. 1887, 94.
Whangarei, Palmerston, Christchurch.

285. *C. agriopa* Meyr., Trans. N.Z. Inst. 1887, 95.
Wellington.

286. *C. mesotypa* Meyr., Trans. N.Z. Inst. 1887, 94.
Auckland, Wellington, Christchurch, Lake Wakatipu, Invercargill.

287. *C. roseata* Meyr., Trans. N.Z. Inst. 1912, 28.
Wadestown, Wainuiomata.

76. Habrophila Meyr.

Habrophila Meyr., Trans. N.Z. Inst. xxi, 161 (1889); type, *compseuta* Meyr.

Head shortly rough-haired. Basal joint of antennae with pecten. Labial palpi with second joint shortly tufted beneath. Maxillary palpi long, folded. Forewings with discal tuft; all veins present. Hindwings lanceolate; 5 and 6 stalked.

Endemic.

288. *H. compseuta* Meyr., Trans. N.Z. Inst. 1888, 161.
Mount Arthur (4,000 ft.).

77. Bascantis Meyr.

Bascantis Meyr., Trans. N.Z. Inst. xlvi, 114 (1914); type, *sirenica* Meyr.

Head shortly rough-haired. Basal joint of antennae without pecten. Labial palpi with second joint tufted beneath. Maxillary palpi long, folded. Forewings with all veins present. Hindwings trapezoidal-ovate, 2–7 separate.

Endemic.

289. *B. sirenica* Meyr., Trans. N.Z. Inst. 1913, 115.
Kaeo, Waitakere Ranges.

78. Archyala Meyr.

Archyala Meyr., Trans. N.Z. Inst. xxi, 159 (1889); type, *paraglypta* Meyr.

Head loosely haired. Basal joint of antennae with pecten. Labial palpi with second joint rough-scaled towards apex beneath, with some apical bristles, terminal joint flatly compressed. Maxillary palpi long, folded. Forewings with all veins present. Hindwings elongate-ovate, 5 and 6 stalked.

Endemic.

290. *A. paraglypta* Meyr., Trans. N.Z. Inst. 1888, 159.
Wellington, Christchurch, Invercargill.

291. *A. pentazyga* Meyr., Trans. N.Z. Inst. 1914, 204.
Wellington.

292. *A. terranea* Butl., Cist. Ent. ii, 510; Meyr., Trans. N.Z. Inst. 1887, 100.
Wellington, Christchurch, Castle Hill, Lake Wakatipu, Dunedin, Chatham Islands. Larva on moss.

79. Sagephora Meyr.

Sagephora Meyr., Trans. N.Z. Inst. xx, 95 (1888); type, *phortegella* Meyr.

Head shortly rough-haired. Basal joint of antennae without pecten. Labial palpi with second joint rough-scaled beneath, with some long bristles. Maxillary palpi long, folded. Forewings with all veins present. Hindwings elongate-ovate; 4 absent.

Endemic.

293. *S. felix* Meyr., Trans. N.Z. Inst. 1913, 114.
Kaeo, Wellington.

294. *S. phortegella* Meyr., Trans. N.Z. Inst. 1887, 96.
Taranaki, Makatoku, Wellington, Nelson, Otira River, Christchurch, Dunedin, Lake Wakatipu.

295. *S. steropastis* Meyr., Trans. N.Z. Inst. 1890, 100.
Wellington.

80. Thallostoma Meyr.

Thallostoma Meyr., Trans. N.Z. Inst. xlv, 28 (1913); type, *eurygrapha* Meyr.

Head rough. Basal joint of antennae with pecten. Labial palpi with second joint slightly rough-scaled beneath. Maxillary palpi moderate, curved, ascending. Forewings with cell very long; all veins present. Hindwings elongate-ovate; 5 and 6 short-stalked.

Endemic.

296. *T. eurygrapha* Meyr., Trans. N.Z. Inst. 1912, 29.
Ohakune, Wadestown.

81. Trichophaga Rag.

Trichophaga Rag., Ann. Soc. Ent. Fr. lxiii, 123 (1894); type, *swinhoei* Butl.

Head rough. Labial palpi moderate, porrected. Maxillary palpi long, folded. Forewings with 10–12 successively running each into vein following it, not reaching costa. Hindwings elongate-ovate; 2–7 separate.

A genus of one African species and two others now widely distributed by artificial introduction, but probably originating round the Mediterranean.

297. *T. tapetiella* Linn., Syst. Nat. 536; Meyr., Trans. N.Z. Inst. 1887, 98; *palaestrica* Butl., Proc. Zool. Soc. Lond. 1877, 404.
Wellington, Nelson; occurs also in Europe, North America, and Australia, being replaced by another species, *abruptella* Woll., in warmer intermediate regions. Larva on furs and woollen stuffs.

82. Monopis Hb.

Monopis Hb., Verz. 401 (1826); type, *rusticella* Hb. *Blabophanes* Zell., Linn. Ent. vi, 100 (1852); type, *rusticella* Hb.

Head rough. Labial palpi moderate, porrected. Maxillary palpi long, folded. Forewings with more or less developed subhyaline spot in cell; 3 and 4 stalked. Hindwings elongate-ovate.

Not very numerous, but of general distribution. Larvae feed on refuse.

298. *M. ornithias* Meyr., Trans. N.Z. Inst. 1887, 97.
Christchurch.

299. *M. ethelella* Newm., Trans. Ent. Soc. Lond. (2) iii, 288; Meyr., Trans. N.Z. Inst. 1887, 97; *rectella* Walk., Cat. xxviii, 482; *namuella* Feld., Reis. Nov. pl. cxl, 44.
Auckland, Palmerston, Nelson, Mount Arthur (to 4,000 ft.), Christchurch, Dunedin; also common in Australia.

300. *M. crocicapitella* Clem., Proc. Acad. Nat. Sci. Philad. 1859, 257 ; *ferruginella* Meyr., Trans. N.Z. Inst. 1887, 97 (*nec* Hb.).
Taranaki, Napier, Wellington, Mount Arthur (to 4,000 ft.), Nelson, Christchurch ; also occurs in Europe, Africa, North America, and Australia. The true *ferruginella* is much more restricted in distribution.

83. Tineola Herr.-Schäff.

Tineola Herr.-Schäff., Schmett. Eur. v, 23 (1853) ; type, *biselliella* Hüm.

Head rough. Labial palpi moderate, porrected. Maxillary palpi short, simple, porrected. Forewings with all veins present. Hindwings elongate-ovate.
Principally developed in Africa.

301. *T. biselliella* Hüm., Ess. Ent. iii, 13 ; Meyr., Trans. N.Z. Inst. 1887, 101.
Christchurch, Lake Wakatipu ; also in Europe, North Africa, North America, and Australia. Larva on hair and wool, often destructive in furniture-linings.

84. Tinea Linn.

Tinea Linn., Syst. Nat. 534 (1758) ; type, *pellionella* L.

Head rough. Labial palpi moderate, porrected. Maxillary palpi long, folded. Forewings with all veins present. Hindwings elongate-ovate.
A large and cosmopolitan genus.

302. *T. margaritis* Meyr., Trans. N.Z. Inst. 1913, 116.
Wellington, Tisbury.

303. *T. argodelta* Meyr., Trans. N.Z. Inst. 1914, 204.
Bluff.

304. *T. astraea* Meyr., Trans. N.Z. Inst. 1910, 68.
Invercargill.

305. *T. dicharacta* Meyr., Proc. Linn. Soc. N.S. Wales 1892, 536.
Wellington ; also occurs in east Australia, but scarce.

306. *T. fuscipunctella* Haw., Lep. Brit. 562 ; Meyr., Trans. N.Z. Inst. 1887, 100.
Whangarei, Palmerston, Wellington, Nelson, Dunedin ; also common in Europe, Africa, North America, and Australia. Artificially introduced, being a domestic species. Larva on dry refuse.

307. *T. mochlota* Meyr., Trans. N.Z. Inst. 1887, 100.
Christchurch, Lake Wakatipu.

308. *T. conferta* Meyr., Trans. N.Z. Inst. 1913, 115.
Wellington, Otira River.

309. *T. belonota* Meyr., Trans. N.Z. Inst. 1887, 99.
Palmerston.

310. *T. mysticopa* Meyr., Trans. N.Z. Inst. 1913, 115.
Greymouth, Invercargill.

85. Prothinodes Meyr.

Prothinodes Meyr., Trans. N.Z. Inst. xlvi, 116 (1914); type, *lutata* Meyr.

Head rough. Labial palpi long, curved, second joint shortly tufted, terminal joint compressed, furrowed. Maxillary palpi long, folded. Forewings with all veins present. Hindwings elongate-ovate.
Endemic.

311. *P. grammocosma* Meyr., Trans. N.Z. Inst. 1887, 98.
Wellington, Nelson.

312. *P. lutata* Meyr., Trans. N.Z. Inst. 1913, 116.
Kaeo.

86. Proterodesma Meyr.

Proterodesma Meyr., Subantarct. Islands N.Z. 74 (1909); type, *byrsopola* Meyr.

Head rough. Labial palpi long, curved, second joint rough-scaled beneath, with numerous bristles. Maxillary palpi long, drooping. Forewings with 8–11 becoming obsolete near costa and connected by an indistinct subcostal bar. Hindwings ovate-lanceolate; 6 to costa.
Endemic.

313. *P. byrsopola* Meyr., Subantarct. Islands N.Z. 74.
Auckland Island.

87. Trithamnora Meyr.

Trithamnora Meyr., Trans. N.Z. Inst. xlv, 29 (1913); type, *certella* Walk.

Head rough. Labial palpi moderate, porrected, second joint rough-scaled beneath. Maxillary palpi long, drooping. Forewings with subdorsal tufts; all veins present. Hindwings elongate-ovate.
Endemic.

314. *T. certella* Walk., Cat. xxviii, 484; *improba* Meyr., Trans. N.Z. Inst. 1912, 29.
Wellington.

88. Lysiphragma Meyr.

Lysiphragma Meyr., Trans. N.Z. Inst. xx, 104 (1888); type, *mixochlora* Meyr.

Head loosely scaled. Labial palpi curved, ascending, second joint with rough projecting scales beneath, terminal joint broadly flattened. Maxillary palpi long, drooping. Forewings with subdorsal tufts; all veins present. Hindwings elongate-ovate, transverse vein sometimes absent between 3 and 4.
Endemic.

315. *L. mixochlora* Meyr., Trans. N.Z. Inst. 1887, 105.
Auckland, Makatoku, Wellington.

316. *L. epixyla* Meyr., Trans. N.Z. Inst. 1887, 105.
Wellington, Greymouth, Lake Wakatipu, Invercargill.

89. Titanomis Meyr.

Titanomis Meyr., Trans. N.Z. Inst. xx, 104 (1888); type, *sisyrota* Meyr.

Head shortly rough-haired; tongue well developed. Labial palpi moderate, subascending, second joint shortly rough-scaled beneath, terminal joint short, stout. Maxillary palpi long, folded. Thorax with slight crest, densely short-haired beneath. Forewings with 3 and 4 stalked, 7 to termen. Hindwings over 1, oblong-ovate.

Endemic.

317. *T. sisyrota* Meyr., Trans. N.Z. Inst. 1887, 104.
Otaki, Nelson.

90. Taleporia Hüb.

Taleporia Hüb., Verz. 400 (1826); type, *pseudobombycella* Hüb.

Head rough. Labial palpi moderate, porrected. Maxillary palpi obsolete. Forewings with 7 to termen, 7 and 8 sometimes stalked. Hindwings elongate-ovate, 2–7 separate. Female apterous.

A small European genus. Larvae feed on lichens.

318. *T. scoriota* Meyr., Trans. N.Z. Inst. 1908, 16.
Wellington, Invercargill.

319. *T. aphrosticha* Meyr., Trans. N.Z. Inst. 1911, 123.
Hump Ridge (3,500 ft.).

91. Mallobathra Meyr.

Mallobathra Meyr., Trans. N.Z. Inst. xx, 102 (1888); type, *crataea* Meyr.

Head loosely haired. Labial palpi moderate or short, porrected. Maxillary palpi obsolete. Forewings, with 6 seldom absent, 7 to termen, 7 and 8 stalked. Hindwings elongate-ovate, 6 sometimes stalked with 7 or absent. Female winged.

Endemic.

320. *M. microphanes* Meyr., Trans. N.Z. Inst. 1887, 103.
Christchurch, Dunedin.

321. *M. araneosa* Meyr., Trans. N.Z. Inst. 1913, 117.
Ben Lomond and The Hump, 2,000–3,000 ft.

322. *M. globulosa* Meyr., Trans. N.Z. Inst. 1913, 117.
Invercargill.

323. *M. metrosema* Meyr., Trans. N.Z. Inst. 1887, 103.
Christchurch.

324. *M. lapidosa* Meyr., Trans. N.Z. Inst. 1913, 117.
Wellington.

325. *M. crataea* Meyr., Trans. N.Z. Inst. 1887, 102.
Mount Arthur (4,000 ft.), Invercargill.

326. *M. homalopa* Meyr., Trans. N.Z. Inst. 1890, 100.
Wellington.

92. Scoriodyta Meyr.

Scoriodyta Meyr., Trans. N.Z. Inst. xx, 101 (1888); type, *conisalia* Meyr.

Head loosely haired. Labial palpi moderate, porrected. Maxillary palpi obsolete. Forewings with 7 to costa. Hindwings elongate-ovate, 2–7 separate. Female apterous.

Endemic.

327. *S. conisalia* Meyr., Trans. N.Z. Inst. 1887, 102.
Wellington.

MICROPTERYGINA.

Passing over the *Hepialidae*, I give here the *Micropterygidae* only, whose small size causes them to be neglected except by collectors of the *Tineina.*

17. MICROPTERYGIDAE.

Head rough. Maxillary palpi developed. Posterior tibiae with four spurs. Forewings with jugum. Hindwings without frenulum, with 10 or more veins, neuration resembling that of forewings.

The most primitive family of *Lepidoptera*, including about 60 known species, of which 11 are from New Zealand, but they are probably often overlooked. More forms of this highly interesting and important group probably remain to be discovered in New Zealand, and search is recommended in damp places or margins of brooks in forests at considerable elevations in early spring, before other insects are common. In Europe most of the family occur in very early spring.

93. Mnesarchaea Meyr.

Mnesarchaea Meyr., Trans. N.Z. Inst. xviii, 180 (1886); type, *paracosma* Meyr.

No mandibles. Tongue short. Labial palpi well developed. Maxillary palpi terminating in a porrected brush. Middle tibiae with two apical spurs.

Endemic. A highly interesting and instructive form.

328. *M. paracosma* Meyr., Trans. N.Z. Inst. 1885, 180.
Nelson, Lake Wakatipu, Invercargill.

329. *M. loxoscia* Meyr., Trans. N.Z. Inst. 1887, 90.
Auckland, Wellington.

330. *M. hamadelpha* Meyr., Trans. N.Z. Inst. 1887, 91.
Wellington, Nelson, Mount Arthur (to 4,000 ft.).

94. Micropardalis Meyr.

Micropardalis Meyr., Gen. Ins. cxxxii, 7 (1912); type, *doroxena* Meyr.

Mandibles developed. No tongue. Labial palpi rudimentary. Maxillary palpi long, folded. Middle tibiae with apical bristles, without spurs. Forewings with 7 and 8 separate.

Endemic.

331. *M. doroxena* Meyr., Trans. N.Z. Inst. 1887, 92; Gen. Ins. cxxxii, f. 2.
Auckland, Gisborne.

95. Sabatinca Walk.

Sabatinca Walk., Cat. xxviii, 511 (1863); type, *incongruella* Walk.
Palaeomicra Meyr., Trans. N.Z. Inst. xviii, 180 (1886); type, *chrysargyra* Meyr.

Mandibles developed. No tongue. Labial palpi rudimentary. Maxillary palpi long, folded. Middle tibiae with apical bristles, without spurs. Forewings with 7 and 8 stalked.

Besides the following, there is one species in Queensland.

332. *S. rosicoma* Meyr., Trans. N.Z. Inst. 1913, 118.
Kaeo.

333. *S. zonodoxa* Meyr., Trans. N.Z. Inst. 1887, 91; Gen. Ins. cxxxii, f. 3.
Auckland.

334. *S. quadrijuga* Meyr., Trans. N.Z. Inst. 1911, 126.
Invercargill.

335. *S. caustica* Meyr., Trans. N.Z. Inst. 1911, 124.
Seaward Moss.

336. *S. chrysargyra* Meyr., Trans. N.Z. Inst. 1885, 182.
Lake Wakatipu.

337. *S. incongruella* Walk., Cat. xxviii, 511; Meyr., Gen. Ins. cxxxii, f. 4: *chalcophanes* Meyr., Trans. N.Z. Inst. 1885, 182.
Makatoku, Ohakune, Wellington, Nelson.

338. *S. calliarcha* Meyr., Trans. N.Z. Inst. 1911, 124.
Bluecliff.

INDEX OF GENERA.

Index of Species.

ART. XXVIII.—*Contributions to the Study of New Zealand Entomology, from an Economical and Biological Standpoint: No. 1*—**Plusia chalcites** *Esp.; No. 2*—**Nyctemera annulata** *Boisd.; No. 3*—**Venusia verriculata** *Feld.* (**Lepidoptera**).

By MORRIS N. WATT, F.E.S.

[*Read before the Wanganui Philosophical Society, 23rd November, 1914.*]

INTRODUCTION.

IT is my aim in these and future contributions to bring together as complete a knowledge of each species as is possible. It is of great economic importance that we should know the range or distribution and full particulars of the habits of our native insects. The life-histories may at first sight appear too elaborate, but they are the minimum demanded by the present-day biologist in his researches on the relationship and classification of the *Lepidoptera* and other families. My excuse is that science demands that these details should be known. The bibliographical and synonymic lists appended to each species are as complete as it has been possible to make them. All the more important information gleaned from these has been made use of in the contributions, but where it would have been necessary to make long extracts reference to the original work has been made in the text. I should like to gratefully tender my sincerest thanks to Mr. W. G. Howes, of Dunedin, and Mr. G. V. Hudson, of Wellington, for the kindly help they have given me.

The following keys for the description of the ovum, larva, and pupa in the *Lepidoptera*, showing the minimum of information required, are useful to workers who desire to further our knowledge in this branch. The bibliography below, though not exhaustive, includes works known to the author to be of real assistance to any desiring a sound working knowledge of the subject.

For describing ova:—

(1.) Class (flat or upright).
(2.) Shape (if necessary, transverse and longitudinal sections).
(3.) Dimensions (length, breadth, height).
(4.) Sculpture (smooth, cellular, or otherwise).
(5.) Micropyle (arrangement, number, and size of cells).
(6.) Shell (strong, glossy, transparent, smooth, or otherwise).
(7.) Colour (at laying and subsequent changes).
(8.) Period of incubation; dates of hatching, &c.; manner of laying; other notes of interest.

For describing larvae, the following details should at least be included for each stage—*i.e.*, after each successive moult (Tutt, "Hints for the Field Lepidopterist," pt. iii):—

(1.) Colour and markings; detailed measurements of head, thoracic and abdominal segments; appearance of same; the position of a lateral flange, swellings, &c.; the number and position of prolegs.
(2.) The number of subsegments to each segment, and the variation in their character on different segments.

(3.) The position of the spiracles with regard to these subsegments.
(4.) The character of the hooks on the prolegs; how arranged—whether in complete ring or only on a longitudinal flange, &c.
(5.) The position of the primary tubercles i–vii, and their variation in position on the different segments.
(6.) The structure of the primary tubercles i–vii, and the position of the primary seta (hair) with regard to secondary setae (if any of the latter are present), and the variation in structure according to the different segments on which they are placed.
(7.) The presence of any secondary tubercles other than those already noted as primary i–vii.
(8.) The character of the skin, and the presence or absence of secondary hairs not connected with definite tubercular structures.

Description of Lepidopterous pupae (Tutt, "Hints for the Field Lepidopterist"):—

(1.) The general appearance, especially noting any particular and striking features of the coloration, &c.
(2.) The general structure, especially any particularly striking points of development.
(3.) The exact measurements.
(4.) The general characters of the head, thorax, and abdomen.
(5.) The number of movable abdominal segments.
(6.) Peculiarities of the cremaster.
(7.) Detailed description of the dorsal view: Head (if any visible), pro-, meso-, and meta-thorax (and wings), abdominal segments, traces of tubercular scars, subsegmentation, &c.
(8.) Detailed description of the lateral view: Head, antennae, thoracic segments, and wings, abdominal segments, spiracles, traces of tubercular scars, lateral flanges, &c.
(9.) Detailed description of the ventral view: Mouth parts, antennae, legs, maxillae, wings (with comparative lengths, &c., of these three last-named parts), abdominal segments, proleg-scars, genital organs, &c.

Bibliography.

The Ovum.

Tutt. Nat. Hist. of British *Lepidoptera*, vol. 1, ch. ii, iii, and iv.

Tutt. "Hints for the Field Lepidopterist," pt. 3, ch. ii and iii.

Chapman. "The Phylogeny and Evolution of the *Lepidoptera* from a Pupal and Oval Standpoint," Trans. Ent. Soc. Lond., 1896, p. 567 *et seq.*

Quail. "Embryology of *Lepidoptera* of New Zealand," Trans. N.Z. Inst., xxxiii, p. 159; xxxiv, p. 226.

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The Larva.

Dyar. "Classification of Lepidopterous Larvae," Ann. N.Y. Acad. Sci., viii, pp. 194 *et seq.*

Dyar. "Additional Notes on the Classification of Lepidopterous Larvae," Trans. N.Y. Acad. Sci., xiv, pp. 49 *et seq.*

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Chapman. "Notes on *Micro-Lepidoptera* whose Larvae are External Feeders," Trans. Ent. Soc. Lond., 1894, pp. 335 *et seq.*
Poulton. "On the Ontogeny of *Sphinx convolvuli* and *Aglia tau*," Trans. Ent. Soc. Lond., 1888, pp. 515 *et seq.*
Tutt. Nat. Hist. Brit. Lep., vol. 1, ch. v, vi, and viii; vol. 2, ch. i.
Tutt. "Hints for the Field Lepidopterist," ch. iv.

The Pupa.

Chapman. "On a Lepidopterous Pupa with Functionally Active Mandibles," Trans. Ent. Soc. Lond., 1893, pp. 255 *et seq.*
Tutt. Nat. Hist. Brit. Lep., vol. 2, ch. iii, iv, and v.
Tutt. "Hints for the Field Lepidopterist," pt. iii, ch. v.
Chapman. "Notes on Pupae," Trans. Ent. Soc. Lond., 1896, pp. 129 *et seq.*
Chapman. "On some Neglected Points in the Heterocerous Pupa," Trans. Ent. Soc. Lond., 1893, pp. 118 *et seq.*
Chapman. "The Phylogeny and Evolution of the *Lepidoptera* from a Pupal and Oval Standpoint," Trans. Ent. Soc. Lond., 1896, pp. 567 *et seq.*
Packard. "A New Classification of the *Lepidoptera*," "Bombycine Moths of America," 1895.

'No. 1. **Plusia chalcites** Esp.

Plusia chalcites Esp., Schmitt., 447, pl. 141, 3. *P. verticillata* Guén., Noct., 2, 344. *P. rogationis*, *ib.*, 344. *P. argentifera* Guén., *ib.*, vi, 352. *P. eriosoma* Dbld., Dieff. N.Z., 285; Butl., Voy. Ereb., pl. x, figs. 1, 2; Meyr., Trans. N.Z. Inst., xix, p. 36; Fereday, Trans. N.Z. Inst., xxx, p. 336; Butl., Cat. Lep. N.Z., p. 9, tab. 3, figs. 1, 2; Hudson, N.Z. Entomology, p. 82, pl. 10, figs. 8, 8*a*; Buller, Trans. N.Z. Inst., xiii, p. 237; Fereday, Trans. N.Z. Inst., vi, p. 175. *P. chalcites*, Hudson, N.Z. Moths and Butterflies, p. 35, pl. vi, fig. 3; Meyr., Trans. N.Z. Inst., xliv, p. 104; Lewis, *ib.*, xxxiii, p. 187; Meyr., *ib.*, xlii, p. 69; Hamilton, *ib.*, xliii, p. 122; Longstaff, *ib.*, xliv, p. 113; Watt, *ib.*, xlvi, p. 69; Hudson, *ib.*, xxxiii, p. 187.

The above bibliography refers only to the native species.

The Ovum.

This I have already described in detail elsewhere (Trans. N.Z. Inst., xlvi, p. 69, pl. i, fig. 10).

Egg-laying.

The eggs are laid singly on the underside of the leaves of the food plant. The moth rarely lays more than one egg to a leaf. They are well attached,

and in most cases cannot be removed without damage. The moths lay throughout the summer right up till the end of autumn. The period of incubation differs considerably: in 1912 a batch laid on 20th May hatched on 18th June—that is, twenty-nine days; while this year (1914) a batch was laid on 26th March and hatched on 2nd April—only seven days. The weather during the incubation of this last lot was exceptionally hot, and this no doubt accounts for the shortness of the period. Eggs laid at the end of autumn would, in the case of a cold winter, remain unhatched till the following spring. The moth has a large egg-laying capacity, one in captivity laying over 500 ova within a space of thirty hours. Egg-deposting is carried on during the day as well as at night, though just at dusk is preferred.

The Larva.

1st stadium: Duration, 27th March to 1st April, five days. Length immediately after hatching, $\frac{1}{16}$ in. *Newly hatched:* Colourless; head, prothoracic shield, and tubercles black. A day later the legs become black,

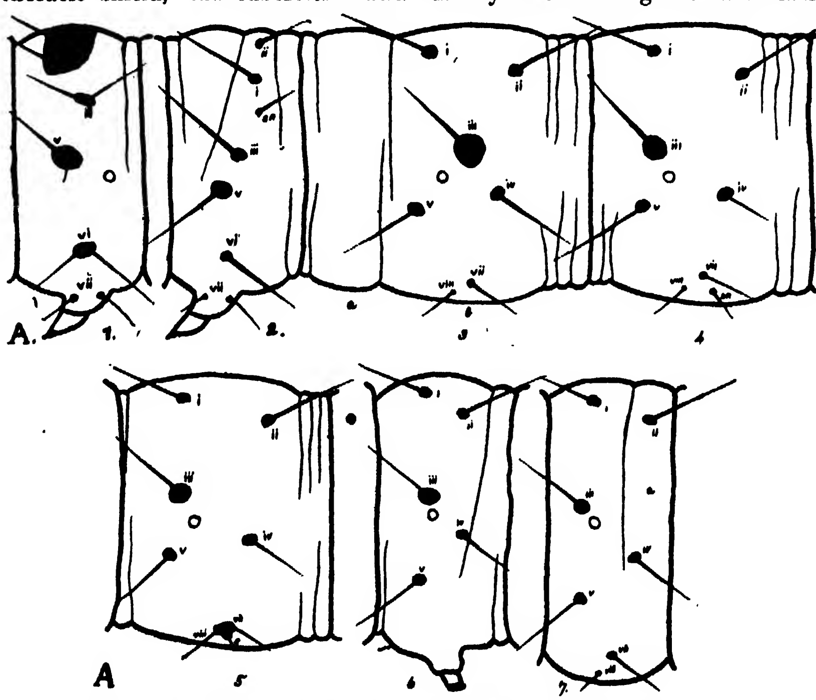


FIG. A.—Larva: 1st instar. 1, prothorax (note position of iii, v, and vi; iv absent); 2, metathorax (iv absent; *sp*, subprimary); 3, 1st abdominal segment (note iii and absence of vi); 4, 2nd abdominal segment; 5, 3rd abdominal segment; 6, 5th abdominal segment; 7, 7th abdominal segment (*a*, posterior subsegment).

NOTE.—Here and in subsequent figures the segments are not drawn to scale, but are lengthened in order to include all the tubercles. The whole importance has been placed in the positions of the various tubercles.

and, owing to the assimilation of food, the body is green. The thoracic segments are darker than the rest of the body, while the last two abdominal segments are blackish owing to the collection of undigested material

within the intestine. The alimentary canal is dark on account of the foodstuff within, and gives the larva the appearance of possessing a dark medio-dorsal stripe. The body is cylindrical, the 5th, 6th, and 10th abdominal segments bearing prolegs which are well developed; the crochets in each are arranged in an almost complete circle. Spiracles small, circular, brown, very inconspicuous. Trachial tubes white and easily seen. The body is clothed with a minute pile, the individual hairs of which are short and bristle-like, and appear to be black-tipped, but require a quarter-inch objective to be distinguished. It appears as though the membrane between the segments were more thinly clothed than the rest of the body, if not entirely smooth. The tubercles are all very conspicuous, and bear simple hairs. The head is well rounded and of medium size. The clypeus and portion between it and the cheeks seems slightly lighter in colour. Mouth parts brownish. Eyes conspicuous. Four fairly long hairs are placed on either cheek between the eyes and clypeus, the two uppermost being situated just below and at either end of the central facial suture, the remaining two are below and slightly anterior to these; the area within the eyes bears 3 smaller hairs in triangular formation, and an 8th very minute one is situated directly beneath the 5th eye. There appears to be ontogenetic relationship existing between these and the primary tubercles on the thoracic and abdominal segments. A black chitinous dorsal shield is present on the prothorax; it is trapezoidal in form, the anterior margin being of greater width than the posterior one. The front portion of the shield carries 4 long hairs directed out over the head, and 4 smaller similarly directed hairs rise from the hinder portion. Excepting a slight swelling of the dorsal portions of the last two thoracic segments above the general surface of the skin, there is no evidence of any meso- or meta-thoracic shield. The 3rd thoracic and 1st, 5th, and 7th abdominal segments are each divided into two subsegments, the posterior subsegment in the last thoracic and 1st abdominal segments being the greater and bearing the primary tubercles. The subsegments of the 5th abdominal are separated by a diagonal suture directed from above anteriorly, the anterior subsegment being the greater and bearing the tubercles. The posterior subsegment of the 7th abdominal is very narrow, but bears tubercles i and iv. The spiracles are situated laterally, slightly below and slightly anterior to the central portion of the segments, but in the 1st thoracic near the hind margin. Tubercle i is included in the prothoracic shield, but is placed beneath ii in the meso- and meta-thorax, being shifted above in the abdominal segments. In the 2nd and 3rd thoracic segments ii is very minute, more so in the meta- than in the meso-thorax, and is also included in the dorsal scutum of the prothorax. A small subprimary tubercle is situated between i and iii in the meso- and meta-thorax. Tubercle iii is well developed, and surrounded by a pigmented area, greatest in the 1st abdominal. It bears a single stout hair, except in the prothorax, where it consists of 2 hairs, fairly minute. Tubercle iii is pre-spiracular, except in the 1st abdominal, where it is post-spiracular; in the other abdominal segments is immediately beneath i, and in the prothorax beneath the posterior margin of the scutum. v is a small single-haired tubercle, subspiracular but anterior to iii; in the prothorax it is greatly enlarged, is supraspiracular, anterior to iii, and bears a minute secondary hair at its base. iv is absent in the thoracic segments, but is post-spiracular in the abdominals and above v, and slightly subspiracular. vi is a large two-haired tubercle on the prothorax, but on the meso- and

meta-thorax consists of a single hair only; is situated beneath v and between v and vii; is absent in the abdominal segments. vii consists of two separate tubercles on the thoracic segments, one on either side of the upper and outer margin of the leg, and seemingly forming the ends of a black semi-circular band that extends around the inner margin of the leg. On the 5th and 6th abdominals vii is absent, but on the rest it consists of a single minute tubercle beneath and slightly in front of iv. viii is extremely minute, and is beneath but anterior to vii. A minute subprimary tubercle appears in the 2nd, 3rd, and 4th abdominals, and is posterior to vii and beneath viii. In the 3rd and 4th abdominals tubercle viii and the subprimary are

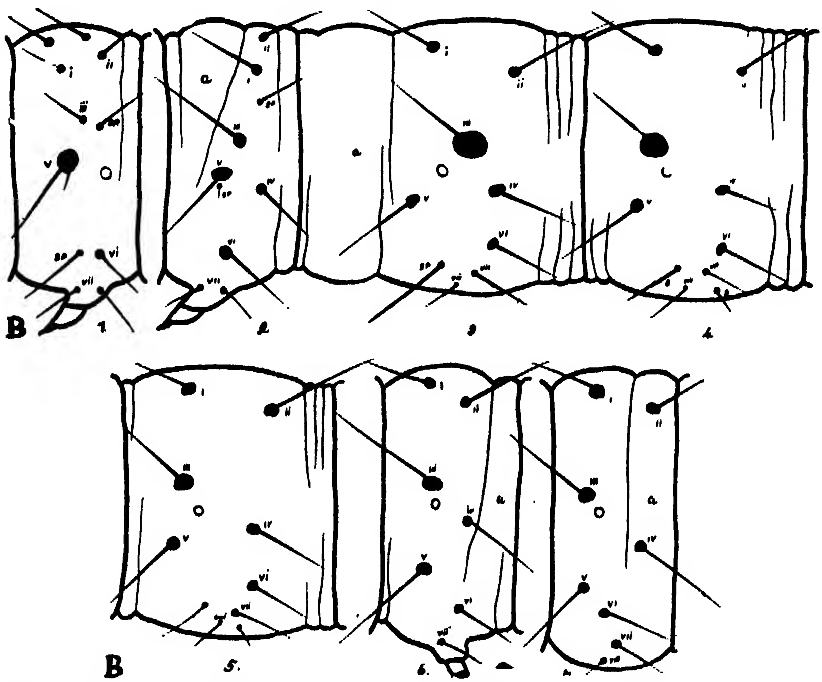


FIG. B.—Larva: 2nd instar. 1, prothorax (note iii and vi); 2, metathorax (iv is now present; *a*, anterior subsegment); 3, 1st abdominal segment (vi present; *a*, anterior subsegment); 4, 2nd abdominal segment (compare with 1st instar); 5, 3rd abdominal segment (compare with 1st instar); 6, 5th abdominal segment (*a*, posterior subsegment); 7, 7th abdominal segment (*a*, posterior subsegment).

moved up to and form a single connected triangular group with vii. The last two abdominal segments are much aborted. The 10th bears the two large anal prolegs, which are directed posteriorly and the suranal plate, which is large, fleshy, and triangular in shape bearing a comb of short stout bristles directed posteriorly. *2nd stadium:* Duration, 2nd April to 6th April, five days. Length immediately after the first moult, $\frac{3}{16}$ in. Head light green, mouth parts brownish, eyes black, legs grey. Body green, darker on dorsal surface; tapering towards head from the 8th abdominal segment. Tubercles bearing single simple hairs, black. The intestine forms a dark-green dorsal stripe, darker anteriorly. The clypeus is margined by a fine black line, which extends also along the central facial

suture. The posterior portion of the cheek bears a conspicuous black streak extending from the top of the head to just above the eyes. In the meso- and meta-thorax the scutellum is not at all distinct, the surface and colouring practically same as rest of body, neither chitinous nor horny. Spiracles as in stadium 1. In the prothorax tubercle i is beneath but a good way in front of ii. A subprimary tubercle is situated above and in front of ii, and a second in front and above i. iii consists now of a small single-hair-bearing tubercle, the second hair having separated and become a subprimary posterior to and slightly below iii. vi has also got rid of its second seta, which is subprimary and immediately in front. In the 2nd and 3rd thoracic segments a very minute subprimary tubercle appears immediately beneath and close to v. Tubercle iv has now made its appearance in the meso- and meta-thorax, and is situated behind v and iii, immediately below i. In the first four abdominals a second small subprimary has appeared anterior to viii and above vii. Tubercles vii and viii are now separated in the 3rd and 4th abdominals, and no longer form the single triangular group with the subprimary. vii is now present as a single small tubercle on the upper anterior portion of the proleg in the 5th and 6th abdominal segments. vi appears in the abdominals, being placed between iv and vii, but below v. *3rd stadium:* Duration, 7th April to 12th April, six days. Length immediately after second moult, $\frac{5}{16}$ in. The 8th abdominal segment bears a posterior dorsal hump. Body tapering from 8th abdominal segment to the head; colour green. In addition to the dark-green medio-dorsal stripe, 2 subdorsal stripes appear, one on either side of the dorsal one, and each consisting of two narrow white lines, the upper one slightly the broader. There is an exceedingly fine white spiracular line. The ventral surface of the body, together with the prolegs, is a light green. The true legs, eyes, and tubercles remain black. In the prothorax tubercle v has got rid of the second hair, which now forms a small subprimary tubercle immediately beneath it. Crochets on prolegs arranged in semicircle. *4th stadium:* Duration, 13th April to 17th April, five days. Length after third moult, $\frac{7}{16}$ in. Spiracles oval. The lower belt of the double subdorsal stripes runs below tubercle ii, while the other and broader belt runs level with it, but is indented so as not to enclose tubercle i. *5th stadium:* Duration, 18th April to 22nd April, five days. Length after the fourth moult, $\frac{5}{8}$ in. A third narrow white stripe is now added to the subdorsal lines and runs above tubercle i, so that now tubercles i and ii are situated in the intervals between the three subdorsal lines. There is a broad supraspiracular line of dark-green fading to the natural body-colour towards the anal end. Tubercle ii is white in the last nine abdominal segments. vi is white in the 3rd to the 9th abdominals inclusive, and v is white in the last abdominal. The tubercles on the suranal plate are white. There is a certain amount of slight variation in the colouring at this stage, but this is dealt with in full in a later pargraph. The sexes can now for the first time be distinguished, but this is also dealt with in the paragraph above referred to. Numerous

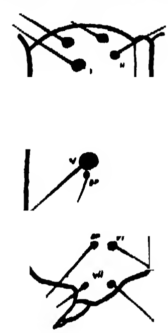


FIG. D.—Prothorax: 3rd instar (note tubercle v, and compare with 2nd instar).

minute irregular white areas are scattered over the body, especially on the ventral and lateral surfaces. During the last four stadiums the pile on the body has been getting not larger or more distinct, but much denser, and covering the whole surface of the body. *6th stadium:* Duration, 23rd April to 4th May, twelve days. Length immediately after fifth moult, 1 in.; full-grown, 1½ in. The black line along the central facial suture and the black margin to the clypeus are now missing. Black cheek-stripe very conspicuous, sometimes consisting of two separate short stripes end to end. Head small, non-retractile, light green in colour. The labrum is large, white, and conspicuous. Mandibles serrated. True legs and prolegs light green. Medio-dorsal and subdorsal stripes as in last stadium. Supraspiracular line ditto. Spiracular line white, broad, very distinct. Numerous small white areas on ventral and lateral surfaces, as in last stadium. Prolegs furnished with semicircle of crochets. Spiracles placed laterally, situated a little beneath and in front of the central portion of the abdominal segments, near the hind margin in the prothorax, oval, brown with dark margin, inconspicuous, those in the 1st thoracic and 8th abdominal segments greatly enlarged. Tubercles all bearing single simple dark-coloured hairs. Pile very dense, extremely minute, seemingly composed of short thick black-tipped bristles. 8th abdominal segment bearing large posterior dorsal hump, the body being much attenuated from it towards the head. Body cylindrical, slightly flattened ventrally. Tubercle iii is well developed, and is surrounded by a large pigmented area, greatest in the 1st abdominal segment, and diminishing in the 2nd, 3rd, and other abdominals. Arrangement of subsegments same as in 1st stadium; tubercles as in stadium 3. The hairs, which can be no decided protection to the body, are set in a peculiar manner, each one having a direction opposite to that of those immediately above and below it: for instance, i is directed up and forward; ii posteriorly and up; iii outwards, forward, and up; iv outwards, downwards, and back; v downwards, forward, and out; vi downwards, backwards, and out. This must surely be the beginning of a more elaborate protective system. Concerning the coloration of the tubercles, i is white, iv and v are white in the 3rd thoracic segment and abdominals; in the first nine abdominal segments all the tubercles are white except iii; there are no black tubercles on the last abdominal. Prior to spinning, the body becomes much lighter in colour, and the dark-green supraspiracular stripe becomes most conspicuous. The spinning of the cocoon takes place some six or more days prior to the final moult. A considerable amount of variation occurs in this stadium, details of which are given in the following paragraph. *7th stadium* (extra moulter): All tubercles white, excepting those on the caput. The black cheek-stripe is very inconspicuous, and sometimes entirely absent.

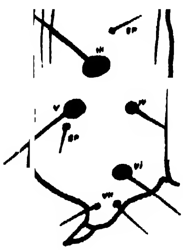


FIG. C.—Mesothorax of male larva in 5th instar (note coalescence of i and ii, and increased size of other tubercles).

Variation.

Larva.—In the 5th and 6th stadiums there is a certain amount of individual variation in the colouring of the tubercles. The most important

feature to be recorded is the difference between the sexes, which is to be found for the first time in larvae during the fifth instar. At this period in their life-history certain larvae (the males) have tubercles i and ii coalesced in the 2nd thoracic segment, while all the tubercles excepting i in the 9th and those on the suranal plate in the 10th abdominal segment are black, slightly enlarged, and most conspicuous. There is also a form very similar to this, the only difference being that tubercles i and ii in the mesothorax are not coalesced; these larvae appear, however, to be only a variety of the female form. In the next, the 6th, stadium it is far more difficult to distinguish the sexes. It appears that the tubercles i and ii in the mesothorax separate again, the only difference between the male and female larvae being that in the male all the tubercles of the thoracic segments are black, whereas in the female tubercles i, iv, and v are white in the mesothorax. There is room for much more work and observation here.

Imago.—Meyrick records a variety in which the golden-white discal spots are wholly absent. This variety appears to be extremely rare. The European species, according to Meyrick, differs very slightly from our species in having the hindwings yellowish anteriorily.

Habits.

Larva.—The young larva emerges at the micropylar end of the ovum, and generally makes its first meal off the empty shell. During the first day its movements are sluggish; later it becomes fairly active, but during the latter stadiums is again very sluggish. Throughout its larval existence it feeds on the underside of the leaves of its food plant, and stretches at full length, the ventral prolegs clasping the stem or midrib of the leaf on which it is feeding. The presence of larvae is plainly betrayed by the large irregular holes eaten in the leaves of whatever food plants they may be on. During the last few seasons the larvae of this moth have evidenced a decided taste for cultivated flower-plants, and in the case of dahlias and asters have acquired the habit of eating right into the heart of the expanding buds; in this way many flowers in full bloom hold a large fat caterpillar, which has absolutely ruined the flower from a marketable point of view. Strange to say, only a very close inspection of the flowers will reveal the true state of affairs, since the larva eats into them from below. It is during the first three stadiums only that the young caterpillars utilize a silken thread for descending from one leaf to another, and as a means of returning to the food plant when forced to drop from harm's way. The methods of defence differ somewhat according to age: during the primary stadiums the larva will at once drop to the ground on being disturbed, but as it grows older will content itself with throwing the fore part of the body sharply from side to side, even making striking movements with the head at the object disturbing it; if forced to drop, it will rapidly curl and uncurl itself with a flicking motion during its drop, and on striking the ground will hurriedly make off to hide among the leaves and rubbish, or, on the other hand, it may roll itself into a ball and remain motionless. Of course, its green colour, its markings and shape, and its habit of remaining on the underside of the leaves, and also of remaining, while eating, stretched out, and thus resembling a portion of a branch of the food plant, afford it great natural protection. A day or so previous to moulting the larva will seek a safe position beneath some leaf, and there stretches itself at full length. The prolegs are firmly attached to the cuticle of the leaf, but the true legs take no hold whatever, being held close against the body. During the next twenty-four hours

the colour gets much lighter, the whole body assuming a light yellowish-green tint. Prior to moulting the new head can be seen occupying the space between the old head and the prothorax, which space is thereby greatly extended. The eyes are plain, and the tubercles and hairs on the new skin can also be seen. The mouth parts of the new head are covered by the old mask. At intervals the fore part of the body lifts slightly, as though the larva were trying to stretch itself. Later these motions become more frequent, and the whole fore part of the body is allowed to hang some distance from the leaf; evidently the muscular effort that before held it straight with the rest of the body has been relaxed. The stretching movements become convulsive, the head meanwhile being thrown from side to side. At last the rear segments appear to swell slightly, the ones in front remaining in their former state; then each segment in turn, from the last abdominal to the first thoracic, is slightly inflated, the whole appearing as an undulatory movement towards the head as if the inner body were gliding within the old skin; having reached the head, the motion begins anew at the anal end and proceeds as before towards the head. Several times this pumping-like action occurs, each new motion commencing on the completion of the previous one, and after each the segments gain in size. Then shortly these motions follow with shorter intervals between, till with one supreme effort the old skin is parted round the neck and the new body appears to be forced out of the old skin segment by segment; in reality the old skin is being forced back. When the prolegs are reached the larva helps free itself by pulling forward. The larva, now free of its old skin, still retains the mask covering the mouth parts; this it rids itself of by rubbing against the leaf, and then, that accomplished, curls itself up to rest. Almost invariably the freshly emerged larva will consume its discarded skin. In the last two or three stadiums the larva spins a light carpet of silk on the surface of the leaf previous to moulting, in order to securely attach the prolegs during the operation of casting its skin. From the time the larva takes up its position previous to moulting till some hours after the moult, the whole period extending sometimes into two or three days, it takes nothing to eat; it is on account of this, and the total removal of all undigested food from the alimentary system, that it becomes so much lighter in colour at these periods. An interesting point connected with the feeding of these larvae is that they can change from one food plant to another—for instance, specimens under observation which had been fed up till the 4th stadium on *S. nigrum* took readily to dahlia, salvia, and potato; and *vice versa*. Temperature and other climatic conditions have a great deal to do with extending or shortening the duration of the stadiums. A cold spell may greatly lengthen them, or even increase the number of stadiums beyond the normal, and also has the effect of dwarfing the larvae; such larvae may hybernate through the winter months.

Recapitulation.

1st stadium: Body green; head black; spiracles circular. 2nd stadium: Body and head green; clypeus black-margined. 3rd stadium: Double white subdorsal stripe appears. 4th stadium: Spiracles oval. 5th stadium: Triple subdorsal stripe; tubercles ii in segments 2 to 10 (abdominals) inclusive white; vi white in abdominals 3 to 9 inclusive. 6th stadium: Black margin to clypeus missing; tubercles on abdominals white, excepting iii. 7th stadium: Extra moulter; tubercles all white.

Periods.

Period of incubation, seven days; weather hot. 1st stadium: March 27 to April 1, five days; length, $\frac{1}{16}$ in.; mild. 2nd stadium: April 2–6, five days; length, $\frac{3}{16}$ in.; mild. 3rd stadium: April 7–12, six days; length, $\frac{5}{16}$ in.; colder. 4th stadium: April 13–17, five days; length, $\frac{7}{16}$ in.; mild. 5th stadium: April 18–22, five days; length, $\frac{5}{8}$ in.; mild. 6th stadium: April 23 to May 4, twelve days; length, 1–$1\frac{1}{2}$ in.; cold. Duration of pupal stage, eighty-five days; cold weather.

Notice the comparatively equal duration of the stadiums, and the influence of the weather upon these. As mentioned in a former paragraph, temperature may be the cause of lengthening or shortening these periods, or even of increasing the normal number of stadiums. By separating one batch into two lots, and treating one of the lots to artificial temperature a few degrees higher than that prevailing in the open, the 3rd stadium was shortened from five to two days only.

Food Plants.

Solanum aviculare, S. nigrum. These were, in all probability, the original food plants, but the larvae have now taken almost exclusively to introduced plants, and are in consequence becoming a dangerous pest to the flower-gardener. The larvae are now seldom found on *S. aviculare,* and then only in parts where introduced plants are still scarce; they still, however, favour *S. nigrum* even in richly cultivated districts. The following introduced plants are eagerly eaten: Dahlia, salvia, geranium, potato, tomato, nettle (introduced), beans, Scotch thistle, mint, horseradish.

Parasites.

The larva is often attacked by a small Hymenopteron belonging to the family *Braconidae.* These parasites, to the number of thirty or more, emerge from their host just prior to its pupating, and spin their small cream-coloured cocoons on the leaves of the plant on which the host has been feeding. The victim may be found later lying upon the ground, its sides scarred by large open circular black-edged wounds from which parasitic larvae have emerged. Prior some days to the exit of the parasites the larva becomes very torpid, moving but little, and eating nothing; externally nothing appears to be the matter with it. The cocoons of the parasite are short, cylindrical, and very fluffy, and are collected in small heaps upon the leaves. One unacquainted with the life-history of these little creatures would often be puzzled to account for the presence of small masses of the cocoons on the leaves of many garden plants. The duration of the pupal existence is about forty-six days. At present this Hymenopteron is unidentified.

The Cocoon.

The favourite situation for the cocoon is between two or more leaves some little distance from the ground. The silk is white and strong, and the cocoon rather fluffy externally, and is never so thick but what the enclosed pupa can be easily distinguished. It often happens that the larvae will forsake their food plant to spin in vegetation yards away. The construction occupies from two to three days.

The Pupa.

At first the pupa is considerably active if disturbed, twirling its abdomen with a circular motion; later, however, it becomes much less active.

The newly formed pupa is bright green in colour, the dorsum shortly becoming dark brown to black. In a week's time the general colouring is black, the ventral parts being lighter in colour. Till shortly before emerging, the base, dorsum, and termen of the forewings retain a considerable amount of the original green. The intersegmental membrane is reddish brown. Laterally the apex of the head is in front of the axial line, the

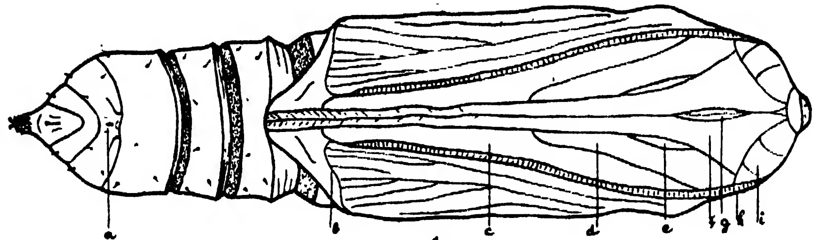


FIG. 1.—Pupa: Ventral view. *a*, female genital organs; *b*, Poulton's line; *c*, 2nd legs; *d*, 1st legs; *e*, femur of 1st legs; *f*, maxilla; *g*, labial palpi; *h*, antenna; *i*, eye.

NOTE.—All illustrations of pupae are to scale.

dorsal line sloping forwards at the prothorax. The dorsal outline of the abdominal segments is practically straight, the individual movable segments, of course, being somewhat rounded when extended. The posterior margin of each movable abdominal overlaps the anterior portion of the segment behind it when the body is contacted, and when in this position the dorsal line is straight. From the 8th abdominal both dorsal and ventral margins rapidly converge towards the cremaster. The anterior convexity of the head terminates laterally in a small prominence above the eye, bending round here and slightly curving downwards and outwards to the end of the first legs. The ventral line continues straight from here to the extremity of the wings, where it is abruptly terminated by the extremity of the maxillae, which protrude from the abdomen for a distance of 0·75 mm. The ventral margin of the abdominal segments below this is straight as far as the 8th abdominal. The anterior extremity of the pupa is about the front portion of the epicranium; from this point it slopes forwards about 2 mm. The labrum is somewhat triangular in shape, rounded between the eyes, and bears 2 small tubercles near its upper margin. The clypeus is marked off by a fine suture. The frontal headpiece is almost square in outline, slightly longer than broad, and forms a prominence above the eyes; it is almost smooth, the only sculpture being a slight network of fine lines, sometimes slightly depressed centrally. There is no dorsal headpiece. The proboscis is prominent, standing out as a rounded keel till about 6 mm. from its origin; throughout this distance it is the most prominent part of the front of the pupa: at first narrow between the cheeks, it then widens out and forms an angle where the 1st leg meets the eye; either side measures 1·70 mm. from middle line to angle; it proceeds, gradually narrowing, to wing-apex, 14·11 mm. The greater part of the maxillae is smooth, though fine lines may be seen with a lens; the basal portion, however, for about 3 mm. is marked with strong

transverse rugae. This rough area varies a good deal in its extent. The central line is divided at the base of the maxillae, and encloses a small triangular portion, the base of which adjoins the labrum; a little farther down, on a line with the base of the eyes, the central line again divides, and encloses a long narrow strip 4 mm. long and about 0·25 mm. across at its greatest width. This area is a portion of the labial palpi, and is divided by a central suture. The antennae show every joint very distinctly, and are somewhat roughened. The scape of each antenna is square in

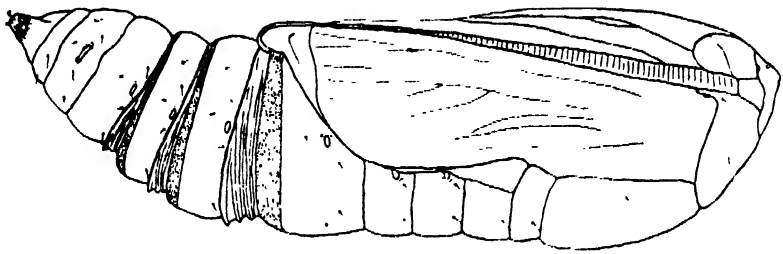


FIG. 2.—Pupa: Lateral view.

outline and plainly marked out. The prothorax has a slight central suture and a sculpturing of fine lines; the posterio-lateral extremities are elongated, forming 2 narrow tongues extending down alongside the antennae for 0·54 mm., the 1st spiracle being imprisoned in the angle so formed, the posterior margin of the prothorax projecting over it like a lid just raised from the aperture. The 1st legs have a narrow margin against the eyes and antennae. are wide and large, the greatest width being 1·25 mm. Between them and the maxillae is a small strip 1·74 mm. long, the 1st femur.

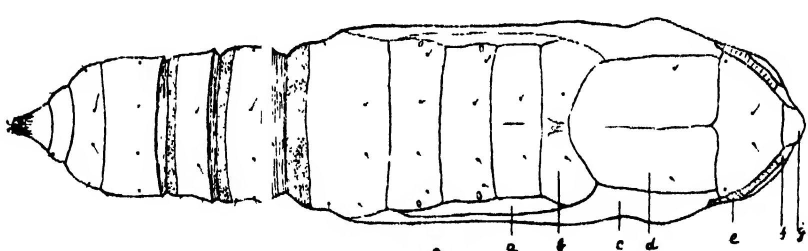


FIG. 3.—Pupa: Dorsal view. *a*, lower or hind wing; *b*, metathorax; *c*, upper or fore wing; *d*, mesothorax; *e* prothorax; *f*, scape of antenna; *g*, frontal headpiece.

The 2nd leg is somewhat narrower than the 1st, both legs having a slight transverse sculpturing. The mesothorax has an appreciable sculpturing in labyrinthine wrinkling, and there is a well-marked central suture. The wings are finely sculptured. and the nervures are easily seen. Poulton's line is gracefully curved, and cuts off a fairly large triangular area. The metathorax has a deep central suture, and is covered with fine labyrinthine wrinkling. The narrow strip of the hindwing has its greatest width at the

juncture of the metathorax and 1st abdominal segment, and disappears opposite the spiracle of the 3rd segment. The abdominals are smoother than the thoracic segments, the 1st abdominal possessing a strong central suture, which is sometimes also traceable on the 2nd segment. Subsegmentation is not apparent. The movable incisions are between 4–5, 5–6, and 6–7. The 5th, 6th, and 7th segments possess a flange on their anterior margin: the surface of the segment, instead of being curved down to the incision, continues directly forwards and then outwards at a sharp angle on the dorsum, but with a little final curve on the sides, to the sharp margin of the flange; the portion of the segment anterior to the flange is furnished with a series of curved transverse rugae, greatest dorsally. When the segments are flexed the anterior surface of the flange comes against the soft flexible posterior margin of the segment in front, which is full and rounded in such a way that the flange fits against it. The spiracles lie laterally behind the flange, forcing it back slightly in the 6th and 7th segments, are oval with raised lips, large and conspicuous; those of the 8th abdominal are abortive. There is no evidence of the larval prolegs. The cremaster (fig. 4) bears 2 large hooks, the extremities of which are whorled and project ventrally and laterally; 4 smaller flattened hooks, arranged one above the other, are situated above these, there being 2 on either side

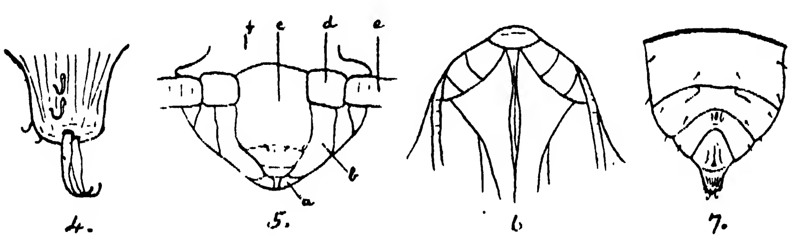


FIG. 4.—The cremaster.

FIG. 5.—Pupa: Frontal view. *a*, maxilla; *b*, eye; *c*, frontal headpiece; *d*, scape antenna; *e*, antenna; *f*, prothorax.

FIG. 6.—Head portion of male pupa (note labial palpi).

FIG. 7.—Genital organs of male pupa.

of the cremaster, and 2 others on the dorsal surface just above the large posterior hooks. The tubercles are nearly all present, but are very minute, and bear very short single simple setae; they occupy the same positions as in the larva, but ii, vii, and viii appear to be absent. The female genital organ is situated on the ventral surface of the 8th abdominal, towards the anterior margin; is represented by a short longitudinal line surrounded by an oval and slightly raised area, and on either side of this the surface of the segment is somewhat elevated anteriorly. The male pupa is distinguished by two very marked differences of structure. The labial palpi occupy almost the whole margin of the labrum between the eyes, and are but slightly constricted between the maxillae (fig. 6). The male genital organs are represented by a very well defined depression guarded by two lips, one right, the other left, and are confined to the 9th abdominal segment (fig. 7). The 8th segment is free from any structure excepting the lateral flattened tubercles mentioned above. The male is slightly more robust than the female pupa.

This pupa has been described much fuller than is necessary, in order to show all the points that must be considered when studying pupae in general. The following table of measurements is valuable and more luminous than any verbal description. The plan is that adopted by Tutt in his "British *Lepidoptera.*" In the pupa the length will vary slightly according to the amount of extension of the free incisions. In the present table the measurements are from a typical specimen with incisions slightly extended.

Table of Measurements.

Measurement at	Length from Front.	Transverse Diameter.	Anterior-posterior. Diameter.
	Mm.	Mm.	Mm.
Top glazed eye	0·50	1·31	1·76
Outer angle maxilla	1·74	4·02	4·51
Prominence at base of forewing . ..	4·00	5·26	6·53
End of 1st legs	7·61	5·20	6·01
End of 2nd legs	13·10	5·10	5·77
End of maxillae	14·11	4·74	5·43
Spiracle, 5th abdominal . ..	14·86	4·00	4·51
" 7th " . ..	17·63	3·80	3·66
9–10 incision	20·23	2·00	1·53
Base of cremaster	21·71	0·66	0·61
Extreme length	22·46	..	

Dehiscence.

The maxillae-cases, leg-cases, and antenna-cases separate in one piece as far as the end of the 1st legs. The headpiece and prothorax are separated in one piece, and are liable to be lost. The eye-covers also appear to separate and to be removed from between the proboscis and the antennae, these latter standing out as a central and two lateral projections to the appendage-cases piece. Dorsally there may be a slight central fracture of the meso-thorax.

The Imago.

This has already been ably described by Meyrick (Trans. N.Z. Inst., xix, p. 36), and by Mr. Hudson in his "New Zealand Moths and Butterflies," p. 35, pl. vi, fig. 3, to which the reader is referred.

Habits of Imago.

The moth is both nocturnal and diurnal, and may frequently be seen during the summer flying swiftly from flower to flower in the hot sunshine. It is common from September till the beginning of June, and specimens may be found during the winter months, provided the cold is not too severe.

Distribution.

Is common in the North Island, but appears to be rare in the southern portions of the South Island, if not quite absent. Has been recorded from Auckland, New Plymouth, Wanganui (March to June), Napier, Wellington, Nelson, Blenheim, and Kamo. Also Australia, Pacific islands, India, Madagascar, South Africa, southern Europe, southern England, and North and South America.

No. 2. Nyctemera annulata Boisd.

Leptosoma annulatum Boisd., Voy. de l'Astr., Ent., v, p. 197, pl. 5, fig. 9 (1853); Doubl., Dieff. N.Z., 2, p. 284. *Nyctemera doubledayi* Walk., Cat. Lep. Brit. Mus., 2, p. 392. *N. annulata* Butl., Cat. Lep. N.Z., p. 4. *Leptosoma annulatum* Bates, Ent. Mo. Mag., 5, p. 2. *Nyctemera annulata* Meyr., Proc. Linn. Soc. N.S.W., 1886, p. 760; Trans. N.Z. Inst., xxii, p. 218; *ib.*, xlii, p. 67; *ib.*, xliv, p. 93: Fereday, List N.Z. Lep., Trans. N.Z. Inst., xxx, p. 331; *ib.*, vi, p. 172 (as *Leptosoma annulatum*): Hudson, Man. N.Z. Ent., p. 73, pl. 9, figs. 3, 3*a*, 3*b*; N.Z. Moths and Butterflies, p. 2, pl. 4, figs. 1, 2, pl. 3, fig. 9: Trans. N.Z. Inst., xlv, p. 65; *ib.*, xxxvii, p. 337: Smith, Entom., 26, p. 220; *ib.*, 34, p. 141: Thompson, N.Z. Naturalist's Calendar, p. 7: Buller, Trans. N.Z. Inst., xiii, p. 238: Quail, Trans. N.Z. Inst., xxxiii, p. 164; *ib.*, xxxiv, p. 228; Entom., 1901, p. 143 *et seq.*: Howes, Trans. N.Z. Inst., xxxiii, p. 188: Philpott, *ib.*, xxxix, p. 213; *ib.*, xxxiii, p. 167: Watt, Trans. N.Z. Inst., xlvi, p. 69: Hamilton, *ib.*, xli, p. 44; *ib.*, xliii, p. 116: Longstaff, *ib.*, xliv, p. 110 (as *Deilemera annulata*): Hutton, Trans. N.Z. Inst., ix, p. 355.

The Ovum.

This I have fully described elsewhere (Trans. N.Z. Inst., xlvi, p. 69).

Egg-laying.

The ova are invariably laid on the underside of the leaves of the food plant, are lightly attached, and are generally arranged in small regular batches of from 10 to 30 or more; occasionally they are laid loosely. The eggs are deposited from September to June, but it seems improbable that the winter is spent in this form.

The Larva.

Although Mr. Quail has already (*Entomologist*, 1901, p. 141) described the larva, it has been found necessary to correct some slight mistakes and omissions. The short summary below is supplementary to Mr. Quail's paper, and should be read in conjunction with it, since it is not intended that it should replace the original description.

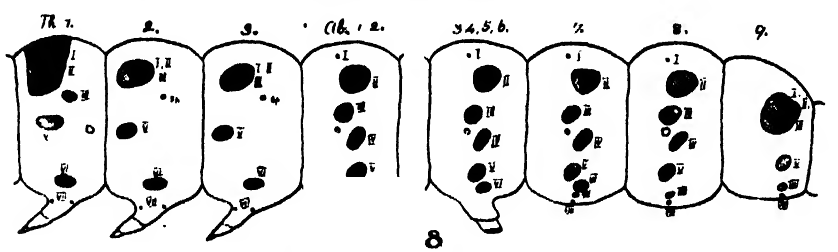


Fig. 8.—Larval tubercles: 2nd and subsequent stadiums.

Tubercle i consists of a small tubercle bearing a single spinulose seta; unlike the other tubercles, it remains in this primitive form throughout the larval life; in the prothorax it is included in the dorsal scutum, and conjoins with ii and iii in the meso- and meta-thorax to form a large

anterior trapezoidal tubercle or wart. ii is beneath and behind i, and is also included in the prothoracic shield. iii is immediately beneath i, and is supraspiracular in the prothorax; it is below and posterior to the scutellum, pre-spiracular, and bears 2 light-coloured setae; it retains this position and primitive form in the prothorax throughout the larval existence. In every stadium there is a minute secondary tubercle bearing a single seta situated below and posterior to the large anterior trapezoidal in the meso- and meta-thorax. v is beneath the spiracle and below iv, is pre-spiracular in the prothorax and immediately beneath the scutum, and in the abdominal segments is inclined to be post-spiracular. iv is absent in the thoracic segments, but is close below and behind the spiracle in the abdominals. vi is present in the thoracic segments above the base of the legs, and posterior to v; in the 1st stadium is absent in the abdominals, appearing, however, in the 2nd and subsequent stadiums in the 3rd to the 7th abdominal segments inclusive, being situated in the 7th abdominal between v and vii but posterior to both; in the other segments mentioned is above the base of the legs, below but posterior to v. vii consists of a small group, one on either side of the upper margin of the thoracic legs: is present directly beneath v in the 1st and 2nd abdominals; is absent in abdominals 3 to 6 inclusive; is below and slightly posterior to v and beneath and anterior to vi in the 7th abdominal. viii is immediately beneath vii—if anything, slightly anterior. There is no alteration in the position of, addition to, or removal of tubercles after the 2nd stadium. The spiracles are circular, with dark rims: small and light in colour during the first two stadiums, but becoming oval and still less conspicuous in the 3rd and subsequent ones. A thick pile covers the body throughout the larval period, becoming thicker and darker after each successive moult. The setae, excepting those of the head, are at all stages spinulose. In the latter stadiums the body tapers towards the head from the 7th abdominal segment.

Development of Larval Markings.

Immediately after hatching, very pale; hairs black, tubercles light-coloured. Second day: General colour a dirty grey to the naked eye, but of a green tint when examined under the microscope. Tubercles, scutellum, and head black, mouth parts and central portion of the cheeks brownish. Towards the end of this period two reddish-brown subdorsal bands extend the whole length of the body, and include tubercles ii and iii, each band being produced ventrally in order to include iii. In the abdominal segments the posterio-dorsal margin of the stripes converge and sometimes unite, forming a narrow transverse belt across the dorsum of each segment. Reddish areas surround the tubercles. *2nd stadium:* Head, legs, and spiracles black. Subdorsal bands as in last stadium. Between the subdorsal bands each segment has an anterior and posterior area of light yellow, the intervening space being white. Body generally light yellow. There is a narrow subspiracular line of reddish brown and a reddish area surrounding tubercle iii. *3rd stadium:* Narrow yellow medio-dorsal stripe. Subdorsal stripes broad, black. Yellow spiracular line interrupted by a large white area on each segment beneath the spiracle. Subspiracular line narrow, very dark brown to black; below this is a very narrow white line with a narrow dark-brown line separating it from the ventral surface, which is of a light-slate colour. *4th stadium:* Dorsal line yellow with a distinct reddish tinge. Subdorsal lines black and very broad. Spiracular lines narrow and broken, reddish yellow. Beneath the spiracular line the

skin is mottled with brown, the ventral surface brownish. *5th stadium* (full-grown): Dorsal line narrow, reddish. Subdorsal stripes black, tubercles blue. Frequently the subdorsal stripes are connected by narrow black transverse bands about the middle of the segments. Spiracular line interrupted by alternate areas of red and yellow. Subspiracular line black.

Variation.

Larva.—There is no marked variation among the larvae, though there may be some slight variation in colour, and also in the comparative lengths, numbers, and coloration of the tubercular setae. It appears that corresponding tubercles on many larvae, and even on the same specimen, do not always bear the same number of setae. In many cases the tubercles bear a certain number of white hairs intermixed with the black ones, but this does not seem to be of any physiological importance, since some larvae possess many more white setae than others do. As a rule, such coloration is symmetrical—that is to say, if certain hairs are white on one tubercle the corresponding hairs on the same tubercles of all the other segments will be white also.

The Imago.—Mr. Hudson records that the species varies a good deal in the extent of the cream-coloured markings.

Table of Main Protective Setae.

The figures in the following table, though as accurate as possible, are only approximate, owing to the difficulty of correctly counting the setae; but they are of interest since they show various phases of growth which will be dealt with fully in the paragraph on habits.

Period.	Length of Longest Hairs on Dorsal Tubercle of the Mesothorax	Length of Longest Hairs on Post-trapezoidal of Abdominals.	Number of Hairs on Dorsal Tubercle Mesothorax.	Number of Hairs on Post-trapezoidal Abdominals.
	Mm.	Mm.		
1st stadium	1·17	0·47	3	4
2nd stadium	1·75	0·82	14	8
3rd stadium	4·10	1·51	36	19
4th stadium	5·53	1·76	38	27
5th stadium	7·57	2·53	40	30

Periods.

Period of incubation, about fifteen days. Hatched, 15th February, 1914. 1st stadium: February 15–19, four days; length, $\frac{1}{16}$ in. 2nd stadium: February 20–23, four days; length, $\frac{3}{16}$ in. 3rd stadium: February 24–28, five days; length, $\frac{5}{16}$ in. 4th stadium: March 1–6, six days; length, $\frac{9}{16}$ in. 5th stadium: March 7–16, ten days; length, $\frac{3}{4}$ in. Length when full grown, $1\frac{3}{8}$ in. Duration of pupal period, March 17 to April 3, eighteen days. Total, forty-seven days.

Table published by Mr. Quail: 1st stadium, seven days; 2nd stadium, six days; 3rd stadium, seven days; 4th stadium, ten days; 5th stadium, fifteen days; 6th stadium, 145 days (hybernated); 7th stadium, twelve days; 8th stadium, fourteen days. Duration of pupal period, thirty-two days. Total, 248 days.

The above table gives a total period, exclusive of the egg state, of forty-seven days. Another batch under observation made a total of seventy-seven days. Contrast these with Mr. Quail's table, with a total of 248 days. Here the normal number of five stadiums has been extended into eight on account of the season, on which account also the larvae hybernated in the 6th stadium for 145 days.

Habits of Larva and Imago.

The Larva. On hatching, the young larva makes its first meal off the empty shell. During the first three stadiums it keeps to the underside of the leaves of the food plant, seldom exposing itself on the upper surface, except perhaps during hot sunshine, and eats only the under portion of the leaf, not eating right through and thereby leaving conspicuous signs of its presence. During this time also it utilizes a silken thread in order to reach fresh feeding-grounds on leaves below, or to regain the food plant if forced to drop to the ground for defensive purposes. The slightest disturbance during these three periods is generally sufficient to make the larva hurriedly drop from the leaves, and on reaching the ground it will curl itself up, the long hairs of the 2nd thoracic and anal abdominal segments intermingling and so protecting the head. The larvae dislike overcrowding, and on coming into contact with one another will rear up the fore part of the body and strike from side to side, even making attempts as though to bite. In the last two stadiums the habits undergo important changes: the larva will freely expose itself while feeding, and, in fact, feeds almost exclusively on the upper portion of the leaves; as a rule, they are not so liable to drop from the food plant when disturbed; they do not use the silken thread if so forced to drop; instead of a life of seclusiveness, they become nomads, often ranging great distances in search of fresh food; and, lastly, they eat large holes out of the leaves of their food plants, thereby making their presence most apparent. In short, their life after the 3rd stadium changes from one of retirement to one of self-advertisement. Turn now to the table of the main protective setae and to the paragraph on the development of the larval markings. You will note in the latter paragraph that the markings during the first half of the larval existence are mainly protective, as distinguished from aggressive, which form they assume during the two latter stadiums. From the table of the main protective setae we find that the number of the hairs increases rapidly during the first three instars, increasing but slightly during the last two; whereas their length increases almost uniformly in each of the five stadiums. Turning now to the period table, one cannot help noticing the similarity in length of time of each of the first three stadiums, and the shortness of their duration as compared with the rest. In the batch mentioned the 1st stadiums occupied only thirteen days out of the total of twenty-nine, and in Mr. Quail's table these three stadiums occupied but twenty days out of a total of 216. The first three stadiums, during which the larva is to a certain extent unprotected and therefore leads a seclusive life, are, on that account, greatly shortened, while the protective development proceeds rapidly. It is in the latter two, during which the protective devices, being almost perfect, change but little, that the greatest amount of growth is attained, and in which the caterpillar spends the greatest portion of its larval life-period. It is unnecessary to dwell further on the above facts.

I have tried many experiments in order to test the sight and sense of direction of these larvae, but no very definite assertions can yet be made

on these points. From my experiments it appears that their sight is poor, and that the larvae are influenced more by large objects, even at a distance, than by much smaller and closer things. Larvae placed in the open on bare ground were seemingly attracted by high trees in the immediate neighbourhood, but failed to observe or direct their way to small food plants and other objects of 2 in. or 3 in. in height placed within a few inches of their path; they even seemed quite unaware of such objects placed right in their way till the long hairs of the thoracic segments, which project out over the head, came in contact with them. This seems rather curious, since a larva will frequently, while crawling on the ground or elsewhere, halt and rear the head as high as possible, as though to take a very comprehensive view of all the surroundings. When they are travelling in the open they always appear to have some definite object in view, and to be going straight to it, and it generally needs an insurmountable obstacle to force them to make a definite change of direction. Larvae crawling over large sheets of cardboard would more or less change their course on the sheet being turned, though they would rarely hit exactly on their original direction; but many more experiments are necessary. Regarding sound and hearing, it seems as though this larva were quite deaf; apparently no amount of noise produces the slightest effect, yet it is appreciable of the minutest vibration imparted to the object on which it may be feeding.

During the summer months they are often to be found crawling over the paths, and can travel at a fair speed; one that was timed traversed 4 ft. in a minute. I am told by several reliable authorities that these larvae are a serious pest to cereal crops, and a few years ago caused a great amount of devastation in the Wangaehu district, ruining field after field of oats; on one occasion numbers of them crossing the railway-line on a steep grade from one field to another caused the stoppage of the express.*

Prior to moulting, the body becomes dark in colour, and the hairs of the coming instar—or, rather, of the new skin—can be plainly seen. The larva seeks a secluded position on the underside of a leaf, and will spin a light silken carpet in which to firmly wedge the crochets of the prolegs. It seems as though this habit of carpet-laying is not acquired till after the third moult. The anterior portion of the prothorax gets greatly extended, and on the sides the eyes of the new head can be distinguished under the overlying layer of skin; the new mandibles can be seen occupying the cheek-spaces of the old head. These characteristics are peculiar to the period just prior to the moult in all lepidopterous larvae. Actual moulting operations are exactly similar to those of *P. chalcites*. The true legs throughout the operation are held close to the leaf, but are not fixed on it in any way. The skin eventually breaks behind the head, and is gradually worked back off the body, the last few abdominal segments, however, being pulled out by the larva itself. During the next hour or two it will remain quiet, occasionally making convulsive movements in order to expedite the drying and setting of the setae. The actual process of moulting may occupy only a minute or less.

The Imago.—The imago is diurnal, and is a rather lazy flyer, except during the early hours of the morning soon after sunrise and in the early evening, when it may be seen flying very high and around the tops of the

*** Since writing the above I have communicated with Mr. G. V. Hudson on this subject. He says he has never heard of the larva feeding on oats. Probably my informants may have made a mistake in identity.**

highest trees. This peculiarity has been recorded by several observers. While resting, the wings are held flat, the dorsal margins of the upper wings being parallel, thus giving the moth its characteristic triangular appearance.

The Cocoon.

Prior to spinning, the larva becomes very restless if disturbed, wandering hastily and aimlessly about the food plant, and feeds but little, if at all. Later it forsakes the food plant, those in captivity having a tendency to crawl to the top of their breeding-cage. The cocoon is constructed amongst neighbouring rubbish on or near the ground, a favourite place being under the loose bark of near-by trees. Actual spinning operations last about two days. The cocoon appears to be constructed in two portions—an outer and somewhat fluffy case, after the construction of which the larva rests some hours; and an inner and more close and compact lining, sticky, and containing a large number of the long spinulose hairs of the larva; these, being but loosely set in the larval epidermis, become caught in the lining of the cocoon during spinning and become detached, and so help to strengthen it. When all is finished the larva rests in an inverted position, and about two days later undergoes the final moult, appearing as a pale-white-coloured pupa. It rapidly attains its black and yellow coloration, which it retains till just prior to the emergence of the imago, when the yellow areas become almost entirely obscured, the general appearance being black. Hutton records (Trans. N.Z. Inst., ix, p. 355) that the pupa is hung to trees, palings, grass, &c.: this must undoubtedly be a mistake.

Food Plants.

New Zealand groundsel (*Senecio bellidioides*), *Senecio scandens*, *S. vulgaris*, *Cineraria maritima*; also responsible for the large holes so often to be seen in the rangiora-leaves (*Brachyglottis repanda*); has been found feeding on *Senecio Turneri*, *S. Hectori*, *S. sylvaticus*, *S. latifolius*, *Erechtites arguta*, and cereals.

Parasites.

Nemorea nyctemerianus. Mr. Hudson records ("Manual of New Zealand Entomology," p. 59, pl. 7, fig. 6) that the eggs are deposited on the moth-larva at an early age. The maggot eats its way out during the pupal stage of the moth, and changes into a dark-brown pupa, being protected by the cocoon of its host. I have not come across any of these parasites in the Wanganui district

The Pupa.

It has been found necessary to rewrite Mr. Quail's description, owing to several omissions concerning important structural details which if included here by themselves would be valueless for want of further information.

Length, ⅝ in.; greatest width, about ¼ in. The general colour is black, but there may be a slight brownish tinge in some; the nervures of the wing-cases are yellow. Mr. Quail records one specimen having the wing-cases almost entirely yellow. Yellow areas on the abdominal segments form 4 longitudinal lateral series, 1 large mid-ventral, and a large mid-dorsal. The shape is robust, thickest near the posterior margin of the 3rd abdominal segment. The head is ventral; mesothorax swollen anteriorly, and a waist is formed dorsally at the juncture of the metathorax and the 1st abdominal segment. The wing-cases extend to the ventral posterior edge

of the 4th abdominal; a narrow strip of the hindwing extends to the posterior edge of the 3rd abdominal; Poulton's line cuts off a very narrow strip only. The spiracles are conspicuously elevated, position on 2nd abdominal almost dorsal, on other segments placed rather high: colour black; shape oval. The abdominal incisions are distinct and sharp; the anterior edge of the segments has a flat sloping rim, and all are covered with innumerable minute pits, which Quail considers are probably associated with the fine larval hairs. The pupa has no power of movement. Quail writes that he could find no trace of setae corresponding to the tubercle-setae of the larva, but this is a mistake. During an early period of the pupal existence—that is to say, before the yellow abdominal areas become obliterated—groups of minute hairs may be found on the black areas, and these correspond with

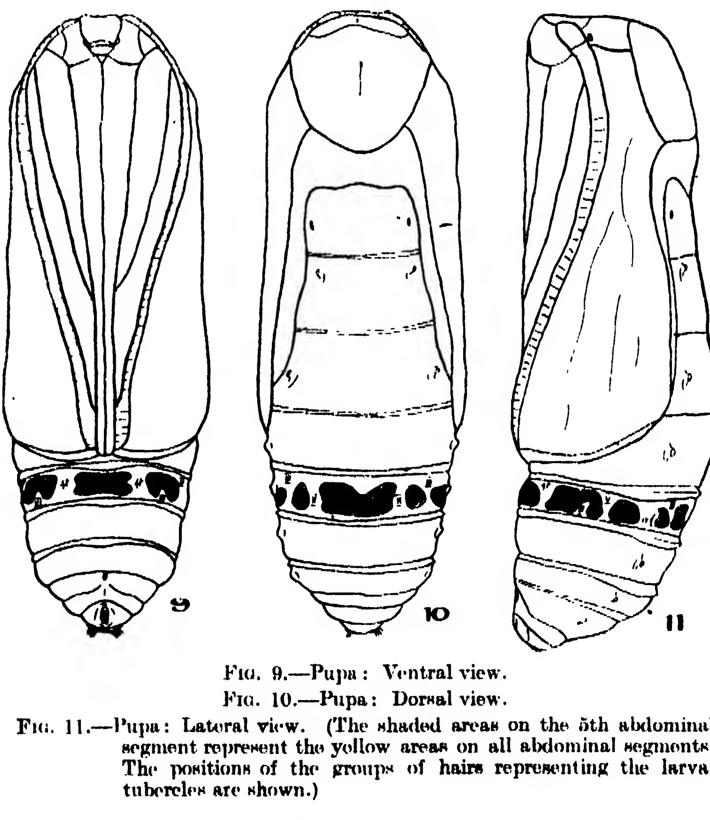
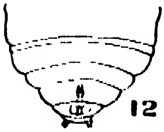


FIG. 9.—Pupa: Ventral view.
FIG. 10.—Pupa: Dorsal view.
FIG. 11.—Pupa: Lateral view. (The shaded areas on the 5th abdominal segment represent the yellow areas on all abdominal segments. The positions of the groups of hairs representing the larval tubercles are shown.)

the larval tubercles, as I have shown on the 5th abdominal segment only in the figure. Further than this, the larval prolegs are represented by slight depressions on the ventral surface of the segments; these depressions bear groups of minute bristle-like hairs. The terminal segment is round and blunt; the anal armature consists of 2 sets of hooks, 12 each, at either side of the dorsal posterior extremity. The prothorax bears a central strong longitudinal ridge, which extends into the frontal headpiece and mesothorax. The antennae extend as far as Poulton's line, and form a slight prominence on the ventral surface, as can be seen when the pupa is viewed from a lateral aspect. Segmentation is very plain. The maxillae are comparatively

narrow, and extend to the end of the wing-cases. Small scars representing the mandibles are to be found on either side of the clypeus. The 1st legs are stout, and the margin against the eye is equal in length to the corresponding margin against the maxillae. The 2nd pair of legs are long and narrow. The frontal headpiece is triangular in shape. On the female pupa the



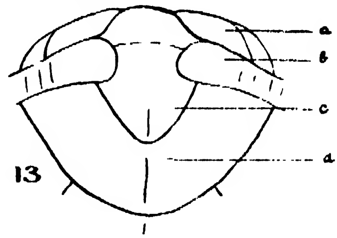


FIG. 12.—Pupa: Male genital organs.
FIG. 13.—Pupa: Frontal view. *a*, eye; *b*, antenna; *c*, epicranium; *d*, prothorax.

genital organs are confined to the 8th abdominal segment, which is greatly encroached upon on the ventral surface by the 9th abdominal. The anal scar in the 10th abdominal in both male and female pupae is raised and prominent. Duration of pupal stage, three to five weeks, and longer; many probably pass the winter in this stage.

Dehiscence.

"Dorsally split down middle of meso- and meta-thorax, and transversely at suture of same; the headpiece, with eyes, legs, and antennae intact, separates from costal edge of wing-cases, except at their tips" (Quail, *ibid.*).

Measurements of Pupa.

Measurement at	Length from Front.		Transverse Diameter.		Anterior-posterior Diameter.	
	Male.	Female.	Male.	Female.	Male.	Female.
	Mm.	Mm.	Mm.	Mm.	Mm.	Mm.
Outer angle of maxilla	1·76	1·41	4·00	3·75	4·50	4·50
Posterior margin of mesothorax	3·81	3·76	5·46	5·15	4·90	4·70
Dorsal depression	4·30	4·30	5·57	5·36	4·87	4·66
End of 1st legs	7·25	7·25	5·76	5·76	5·50	5·00
End of 2nd legs	10·00	8·75	6·00	6·00	6·05	5·50
End of maxillae	11·25	10·00	5·00	5·00	4·76	4·67
Posterior margin of 7th abdominal segment	15·35	14·20	3·76	3·76	3·00	2·75
Ditto, 10th abdominal segment	17·26	16·00	1·15	1·15	0·60	0·50
Extreme length	17·50	16·25	..	..	..	..

The Imago.—See Meyrick (Trans. N.Z. Inst., xxii, p. 218) and Hudson (N.Z. Moths and Butterflies, p. 2, pl. 4, figs. 1 and 2; pl. 3, fig. 9).

Distribution.—North and South Islands, Stewart Island. Confined to New Zealand, but two closely allied species belonging to the same genus are found in Australia. Has only been recorded from Waiouru (rare), New Plymouth, Wanganui (common), Lumsden (common), Mount Holdsworth, Kermadec Islands (apparently common).

No. 3. **Venusia verriculata** Feld.

Cidaria verriculata Feld., Reise der Nov., 5, pl. cxxxi, fig. 20. *Philalapteryx verriculata* Butl., Proc. Zool. Soc. Lond., 1877, p. 396. *Panopoea verriculata* Meyr., Trans. N.Z. Inst., xvi, p. 62. *Pancyma verriculata* Fereday, Trans. N.Z. Inst., xxx, p. 338. *Venusia verriculata* Hudson, N.Z. Moths and Butterflies, p. 53, pl. 6, figs. 30, 31. *Pancyma verriculata* Meyr., Trans. N.Z. Inst., xviii, p. 184. *Venusia verriculata* Philpott, Trans. N.Z. Inst., xxxiii, p. 175: *ib.*, xxxix, p. 216: Hamilton, Trans. N.Z. Inst., xliii, p. 121: Watt, Trans. N.Z. Inst., xlvi, p. 80.

The Egg.

For detailed description, see Trans. N.Z. Inst., xlvi, p. 80.

Egg-laying.

The ova are deposited in small regular batches of a dozen, more or less. The parent moth is careless as to the spot where she lays her ova, for they may be found on both dead and green leaves alike. It would appear from the rapid colour-changes in the egg and the extreme activity of the newly hatched larvae that the correct place for the ova is on the dead leaves, and they are often to be found there on the under-surface near the base of the leaf, where they are greatly protected by their colour. Those eggs laid on the green leaves only gain protection on account of their colour for a couple of days or so, and for the remainder of the oval period are startlingly conspicuous; in consequence the collector is bound to come across them in such positions, and, as they are well-nigh invisible on the dead leaves, his opinion is likely to be prejudiced as to the natural place of deposition. Personally, I have found more ova on the dead leaves, where they have invariably been placed on the under-surface, near the butt, than on the fresh leaves, on which they appear to have no fixed position. One female reared in captivity laid a total of 393 eggs in three days. Oviposition was carried on during the night. In most of the batches the eggs are laid in neat rows, being placed end on end, but occasionally they are to be found in a rather scattered condition.

The Larva.

1st stadium: Head of medium size, non-retractile. Abdominal segments 1 to 6 inclusive are largest and equal in size; the 7th abdominal and the thoracic segments about equal. Body cylindrical; prolegs on abdominal segments 6 and 10 only, situated posteriorily, well developed, crochets on lateral flange. A very minute and scattered pile may be observed on the body with a high-power objective. The 6th abdominal segment is divided centrally into two subsegments; on the other segments subsegmentation is not apparent. Spiracles small, circular, rims brown, inconspicuous. The prothoracic shield is slightly raised and light in colour, with a well-marked medio-dorsal suture; each half of the scutum bears 4 minute tubercles and setae arranged in diamond formation. All setae are simple. Tubercle i is contained in the scutum on the prothorax; in the remaining two thoracic segments is above ii, slightly anterior; in the abdominals i and ii are some distance apart, i being anterior to and above ii. ii is also included in the prothoracic shield. iii consists in the thoracic segments of two minute tubercles, sometimes free, sometimes coalesced; in the prothorax they are situated just beneath the scutum, the upper one

being slightly posterior; in the meso- and meta-thorax the position is some distance beneath but anterior to i and ii, and the position of the two tubercles reversed—that is to say, the upper one is anterior, instead of posterior as in the prothorax. In the abdominal segments iii is pre-spiracular, below but anterior to i; appears to be absent in the 9th abdominal. iv is absent in the thoracic segments, but in the abdominals is post-spiracular, immediately beneath ii, and slightly subspiracular. v is a large tubercle in the prothorax having one large and one small seta, is pre-spiracular and beneath iii; consists of a single-hair-bearing tubercle beneath iii in the meso- and meta-thorax; in the abdominals is subspiracular beneath iii, and in the 9th abdominal immediately beneath iv. vi and vii are coalesced in the 1st thoracic segment, situated above the leg, vi anterior to vii; in the 2nd and 3rd thoracics vii is situated above the outer posterior margin of the leg, posterior to v; is absent in the abdominals. vi is also absent in the abdominal

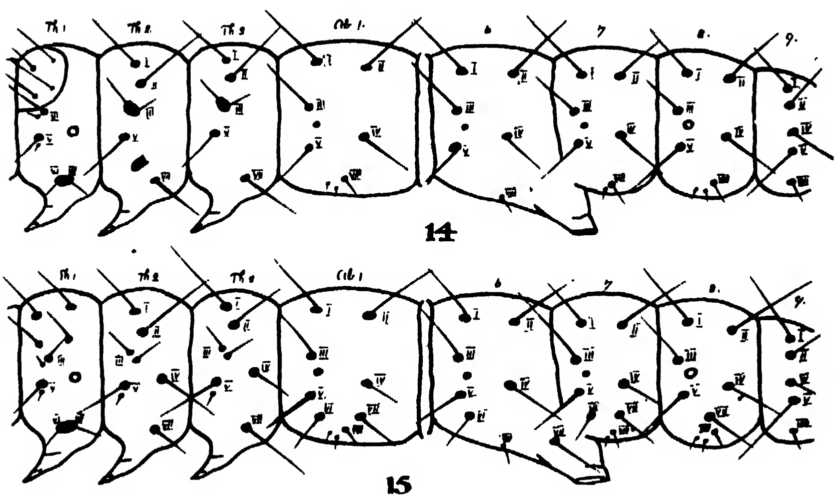


FIG. 14.—Larval tubercles: 1st instar.
FIG. 15.—Larval tubercles: 2nd instar.

segments. viii is a very minute tubercle on the ventral surface anterior to vii, immediately beneath v in the 9th abdominal. Two secondary setae are situated on the ventral surface anterior to viii. *2nd stadium:* The thoracic plate is not distinguishable on the prothorax. Tubercles i, ii, iii, v, and viii as in 1st stadium. iv now appears in the 2nd and 3rd thoracic segments above and posterior to v. A small secondary tubercle is situated just beneath and slightly in front of v in the meso- and meta-thorax. vi appears in the first seven abdominal segments immediately beneath the spiracle and beneath but posterior to v. vii in the abdominals is beneath iv, immediately posterior to vi, except in the 6th segment, where it is situated on the upper and outer margin of the leg. This is the final arrangement of the tubercles, and remains constant throughout the 3rd, 4th, and 5th instars. *3rd stadium:* Abdominal segments 6 and 7 are divided medially into two equal subsegments. Pile exceedingly minute. *4th stadium:* As in stadium 3. Spiracles circular, excepting those on the first thoracic and 7th and 8th abdominal segments, where they are inclined to be oval.

5th stadium: Spiracles oval, brown. Subsegmentation on abdominal segments 1 to 7. Pile thick but very minute. Body of equal width throughout, slightly flattened dorsally and ventrally. The head is medium-sized, somewhat square in shape; clypeus small and distinct, possessing 4 minute setae; either cheek has 7 setae, the area included by the eyes bears 4 with a 5th more remote: mandibles serrate, with 5 points.

Development of Larval Markings.

1st stadium: General colour light green. Head light green with light-brown mouth parts; eyes black. Has a conspicuous brown spiracular line. Tubercles light-coloured. *2nd stadium:* Broad medio-dorsal stripe of dark green. Spiracular stripe dark brown to black. *3rd stadium:* A light-brown stripe extends from either side of the base of the clypeus to the top of the head, but they are some distance from the central facial suture. *4th stadium:* A very narrow white subdorsal line appears on either side of the broad medio-dorsal stripe. Cheek-stripes ochreous and very conspicuous; while a third short thick stripe occupies the central portion of the clypeus. The tubercles are still light in colour, excepting iv, which is included in and is of the same colour as the spiracular band. *5th stadium* (full-grown): General colour green, ventral surface light. The narrow white subdorsal stripes are margined on either side by a pinky area. Tubercles black. Head-markings very strong, as in last stadium, the facial markings extending across the prothorax, where they are black. Suranal plate and upper portion of anal prolegs black. Before spinning the whole body assumes a rosy hue.

Variation in Larva and Imago.

The Larva. Here there is not much variation, chief instances being the absence of the spiracular lines and cheek-stripes, and in the coloration of the tubercles. There appears to be a variety which is, when full-grown, larger ($1\frac{1}{16}$ in. to $1\frac{1}{4}$ in. in length), greener in colour, and not having such marked subdorsal lines. This may be explained sexually.

The Imago.—A certain amount of variation occurs in size and colour, some specimens being brighter in the shades of brown than others.

Table of Periods.

Period of incubation from fifteen to twenty-two days, or longer. 1st stadium: fifteen days; length on hatching, $\frac{1}{16}$ in. 2nd stadium: thirteen days; length after 1st moult, $\frac{3}{16}$ in. 3rd stadium: thirteen days; length after 2nd moult, $\frac{5}{16}$ in. 4th stadium: twelve days; length after 3rd moult, $\frac{7}{16}$ in. 5th stadium: twenty-one days; length after 4th moult, $\frac{9}{16}$ in. Larva, full-grown, $\frac{3}{4}$ in. to $1\frac{1}{4}$ in. in length; length before pupating, $\frac{1}{2}$ in. only; duration of spinning, about two days; duration of larval life within the cocoon, four to five or more days; duration of pupal existence, fifty days (winter months).

Habits.

The young larvae on hatching do not eat the empty shells, but almost immediately start climbing. At first they are very active, and able to crawl long distances, betaking themselves to the innermost leaves of the cabbage-tree, where they are wont to congregate together on the upper but inner surface of the loose outer leaves forming the heart spike of the tree. Throughout the first four stadiums their method of feeding is to scoop long channels

out of the surface of the leaves parallel to the fibres; later, however, in their 5th stadium, they attack the edges, eating out great lumps, which, as the leaves grow and begin to droop outwards, give to them a very notched and serrated appearance. It is unfortunate that the larvae attack the youngest leaves, for it is not till these grow up that the tree shows any sign of the presence of caterpillars, and then it is nearly always too late to do any good, unless there be a second or third brood, for the larvae will in all probability have retreated to the mass of dead leaves hanging around the tree, or among the rubbish on the ground, to pupate. On carefully pulling apart the outer leaves of the inner spike one is almost certain to find numbers of larvae in all stages of growth, the younger ones being generally found in groups. No sooner, however, are the leaves opened than the larvae will immediately drop into the crevices, many being crushed to death when the leaves resume their former position on being released. One would think that in extremely wet weather many would stand a good chance of being drowned in the water that collects round the base of the leaves, but they may frequently be found wallowing in this, seemingly without the slightest harm. Specimens in captivity invariably kept to the underside of the leaves of the food plant, but in a state of nature they are frequently to be found feeding fully exposed on the more mature leaves; here they probably enjoy the warmth of the sun. Full-grown larvae are never to be found in such exposed situations unless searching for a suitable place in which to pupate. Throughout all the stadiums the larvae make use of a silken thread. When disturbed they do not throw the head from side to side or curl up, as most caterpillars, but either drop or hurriedly seek to hide themselves in the spaces between the leaves. The young utilize the thread for dropping from leaf to leaf in search of food. The silk is exceedingly strong and elastic. Trees that have been badly infected will be found to be almost destitute of the inner compact and succulent heart, while great quantities of the coarse frass will be piled up around the base of the leaves. The larvae during the last stadium have enormous appetites, and it is at this period that most of the damage to the tree is done. Many appear to suffer from a wasting disease; they quit feeding, and the segments gradually wither up till the head is out of all proportion to the rest of the body. Such larvae invariably die, death in all probability being caused by Ichneumons attacking vital internal organs.

The Imago.—As has been recorded by Fereday and others, the moth frequents the dead leaves hanging from the head of the tree, and invariably sits across the leaf with wings fully spread, which accounts for the peculiar markings of the upper and lower wings, these corresponding to similar lines on the leaves. It is the underside of the dead leaves, where these markings are most distinct, that forms the chief resting-place of the moths. It is in this way that the species is wonderfully protected and almost invisible to an untrained eye. Flight is rather slow, and the moth is nocturnal. Season, September to May.

Food Plants.

Cabbage-tree (*Cordyline australis*; Maori, ti-kouka); *Cordyline Banksii.*

Parasites.

Phorocera nefaria: The larva of this large blue Dipteron is an internal parasite, emerging to pupate when its host is in the pupa state. *Syrphus ropalus* Walk.: The larvae of this fly scour the cabbage-tree heads and

boldly attack and devour all the *V. verriculata* larvae they come across. Further information on the above two species will be given in future contributions. *Cermatulus nasalis* has also been found attacking the larvae.

The Cocoon.

The cocoon is thin and scanty, and is composed of a rather coarse brown silk, which is extremely viscid. When viewed through the microscope the individual threads are bespangled at regular intervals with globules of sticky matter, very similar to the web of a spider. Favourite places for spinning are at the base of the leaves up against the trunk of the tree, in the crevices of the bark, and amongst the dead leaves hanging around the stem.

The Pupa.

Immediately after the last moult the wings, head, and limbs of the pupa are green; the anal segments are light pink, with a strong reddish mediodorsal stripe; the prothorax is pink or rather reddish, and at the juncture of the segments the pink coloration is very marked. Within twenty-four hours the pupa passes through several shades of brown till it is very dark, almost black; the intersegmental membrane between the movable segments is much lighter in colour. The frontal headpiece has three slight prominences, one on either side at the base of the antennae, the 3rd ventral, above the labrum. The thoracic segments bear no very marked dorsal hump, while the abdomen is inclined to be short and stout. Abdominals 5 and 6 alone are movable. The cremaster is short and stumpy, bearing 4 whorled hooks, two on either side, and slightly dorsal. *Dorsal view:* The head is slightly depressed between the antennae, and not visible. The prothorax is narrow, with a central suture, and is somewhat pitted and wrinkled. The 1st spiracle has a long narrow opening, and is very conspicuous. Both the meso- and meta-thorax bear a strong central suture, and are wrinkled. The abdominal segments are strongly pitted, and bear minute hairs that correspond in position with the larval tubercles, but are very hard to distinguish. There is no trace of subsegmentation. The 5th, 6th, and subsequent abdominal segments are swollen anteriorly; this is very marked on the sides and dorsum. The hindwings show a very narrow strip, widest at the 1st abdominal, rapidly narrowing in the 2nd, and again widening slightly in the 3rd and 4th abdominals. *Lateral view:* The apex of the head is in front of the axial line. There is a deep depression in the maxillae some little distance from their origin; from this depression they slope outwards to their extremities near the posterior margin of the 4th abdominal segment; from here the abdominals taper uniformly and rapidly to the cremaster. The whole length of the antenna is visible, the base being level with the top of the eye; it rapidly widens out till on a line with the bottom of the eye, and then gradually narrows towards the tip; every joint is plainly visible. A very slight margin of the hindwing can be seen at the 1st and 4th abdominals. In the forewing Poulton's line is absent, though slight venation can be distinguished. The spiracles are very prominent on raised bases, and are dorso-lateral, oval. *Ventral view:* The

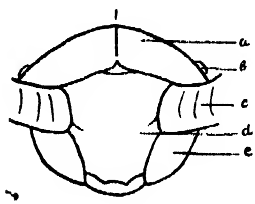
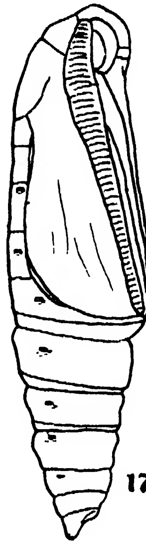


FIG. 16.—Pupa: Frontal view. *a*, prothorax; *b*, 1st spiracle; *c*, antenna; *d*, epicranium; *e*, eye.

maxillae have their greatest width on a line with the bottom of the eyes. Here they form an angle with the eye, and rapidly converge to the end of the 1st legs, where they are extremely narrow, widening out again club-like beyond these again to the end of the wings. The antennae and 2nd legs also reach to the end of the wings. Both legs and maxillae are covered



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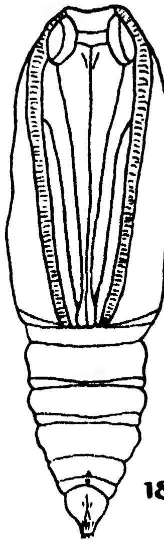

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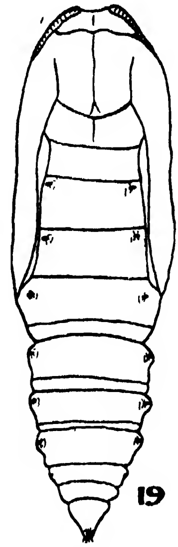

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FIG. 17.—Pupa: Lateral view.
FIG. 18.—Pupa: Ventral view.
FIG. 19.—Pupa: Dorsal view.

with minute transverse rugae, while the wings are sculptured with labyrinthine wrinkling, and the abdominal segments are pitted most anteriorly. The 2nd legs bear an equal width their whole length. Anal scar very prominent. Genital organs inconspicuous, but restricted to their respective segments.

Chief Measurements of Pupa.

Measurement at	Distance from Front.	Transverse Diameter.	Anterior-posterior Diameter.
	Mm.	Mm.	Mm.
Depression in maxillae	1·80	4·00	2·90
End of maxillae	8·70	3·85	3·80
Spiracle, 5th abdominal segment ..	9·50	3·70	3·35
„ 6th „ ..	10·55	3·30	2·90
„ 8th „ ..	12·00	2·25	1·75
Extreme length	14·00	..	..

Dehiscence.

The headpiece, with the eyes and the thoracic and abdominal appendages intact, separates in one piece from the wing-cases except at their tips; the pro-thorax splits down the central dorsal suture; the meso- and meta-thorax remain intact.

Imago.

The imago has already been completely described by Meyrick (Trans. N.Z. Inst., xvi, p. 62) and by Hudson (N.Z. Moths and Butterflies, p. 53, pl. 6, figs. 30 and 31).

Distribution.

Waitakarei Ranges (Auckland); Wanganui, very common from August to May; Wellington; Christchurch and Dunedin, from October to May; Ashburton; West Plains; Invercargill, taken at light in April.

ART. XXIX.—*Contributions to the Study of New Zealand Entomology, from an Economical and Biological Standpoint: No. 4*—Phorocera nefaria *Hutton; No. 5*—Psychoda conspicillata *Hudson; No. 6*—Syrphus ropalus *Walk.; No. 7*—Phytomyza albiceps Mg. (Diptera).

By DAVID MILLER and MORRIS N. WATT, F.E.S.

[*Read before the Wanganui Philosophical Society, 23rd November, 1914.*]

Plates II, III.

No. 4. **Phorocera nefaria** Hutton.

For the original description of this fly see Trans. N.Z. Inst., vol. 33, p. 59, and vol. 36, p. 151.

Since nothing has yet been published concerning the habits and life-history of this Dipteron, which belongs to the parasitic family *Tachinidae*, the following note may be not uninteresting. The larva is an internal parasite of the larva and pupa of the common cabbage-tree moth, *Venusia verriculata* (see Trans. N.Z. Inst., vol. 47, p. 271). The larvae of this moth feed in the crevices between the innermost leaves of the cabbage-tree (*Cordyline australis*), and so it is difficult to see how they become attacked. It is quite possible that the fly deposits its ova on the leaves, and the young maggots on hatching seek out and penetrate their host. But this is only speculation. Only actual observation will reveal the secret, and so it is likely that some little time will elapse before we can complete this very interesting life-history.* The larva, when full-grown, emerges from the pupa of its host, and pupates, being protected by the light cocoon spun by the moth-caterpillar just prior to its final moult and for its own protection.

The pupa is dark red in colour; cylindrical, and smooth; the anterior end slightly smaller than its nadir, which is somewhat pointed. Length of case, $\frac{5}{16}$ in.; greatest diameter, $\frac{3}{16}$ in. In the specimen described the pupal stage lasted from the 10th August till the 1st October—that is to say, sixty-one days. Only one was obtained, and its puparium was almost as large as the pupa of its host, from which it had emerged by bursting through the head. On one occasion at least fifteen imagines were reared

* In all other cases observed a single host has reared but one parasite.

from a single pupa of *Oeseticus omnivorus.** From this it appears likely that the fly may attack other lepidopterous larvae besides, and also tends to confirm the remarks above regarding oviposition.

Hab.—Christchurch (Hutton); Wanganui, October (M. N. W.).

No. 5. **Psychoda conspicillata** Hudson.

Psychoda conspicillata Hudson, Man. N.Z. Ent., p. 46, pl. iv, fig. 6.

This species may be the *Psychoda phalaenoides* Linn. described by Hutton, Trans. N.Z. Inst., vol. 34, p. 179.

As the adult fly has already been fully described and figured, it is unnecessary to do so again here. The following notes are new: During the last few years this beautiful little fly has been found breeding throughout the year in tins of disused liquid horse-manure. The family *Psychodidae* is represented by only a few species in New Zealand. Mr. Marshall (Trans. N.Z. Inst., vol. 28, p. 222) says that the larvae live in fungi and rotten wood. Our New Zealand species are, however, very little known.

Ova and details of oviposition not yet known.

The larva is aquatic, of an elongate form; yellowish-white in colour (description from specimens preserved in 3-per-cent. formol solution); length when full grown, about ½ in., but variable; number of segments, about 25 (?) (fig. 1).

The terminations consist of a downturned anterior and an upturned posterior chitinous-like process, the former very short and stout when compared with the latter, which is elongate, narrowing apically. On the

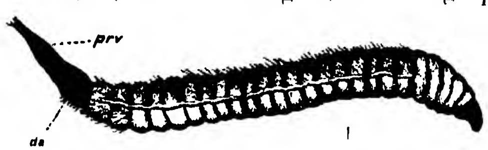

FIG. 1.—Larva of *Psychoda conspicillata.* *ds*, ventral hairs; *prv*, respiratory vesicle.

dorsal surface—exclusive of the first five segments—extending on each side to the medio-lateral line is a vestiture of short reclinate hooked bristles, which, below this lateral line, merge into indistinct and minute delicate hairs, except on the two apical segments, where the bristles form a complete covering. The medio-lateral line is a distinct fold of the cuticle, extending from the anterior margin of the 6th to the terminal segment. This fold is thrown into a series of wrinkles by the contractions of the body-wall.

The respiratory vesicle—the posterior process (fig. 1, *prv*)—is an elongate brownish structure, darker at the apex, and broadened toward the base.

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* Since writing the above some larvae of the moth *Melanchra insignis* were being reared from ova sent to me from Dunedin by Mr. W. G. Howes. At no time during the oval, larval, or pupal stage was it at all possible for flies or other insects to attack the specimens, which were kept in glass dishes with flat glass lids. A fortnight after the pupal stage had been assumed a single larva of *P. nefaria* emerged from one of the pupae by bursting through the 4th abdominal segment, near the dorsum, and pupated. The only possible way in which the victim could have become infected was by means of an egg, or very young larva, of the fly being conveyed into the breeding-glass along with the leaves of the food plant, in this case the common plantain, on which the egg must have been deposited. It is well known that other *Diptera* of similar parasitic habits lay their eggs in this way.

When viewed from the side a swelling is seen upon the ventral surface, from which, at its base, arise numerous short and stiff bristle-like hairs (fig. 1, *ds*). Within the vesicle, and completely filling it apically, are a pair of large tracheae (fig. 2). Arising from the truncated apex, and apparently connected with the tracheae are a number—at least 3—of triangular structures bearing numerous long and sinuated hair-like appendages, each of which is broad and hollow (?) on the basal half but terminates distally in a whip-like filament.

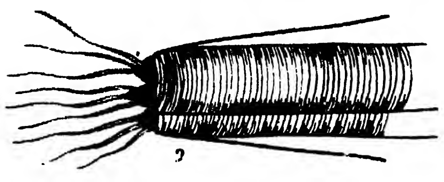


FIG. 2.—Apical tracheae.

The head—anterior process—is roughly triangular in profile, and bears at the downcurved apex a rounded process beset with small hooked bristles (fig. 3, *a*). When viewed from beneath, the head is dome-shaped (fig. 4),

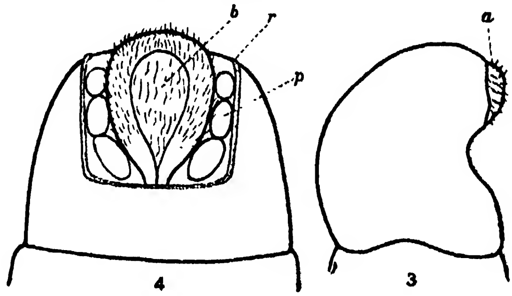


FIG. 3.—Profile of head.
FIG. 4.—Head of larva, ventral view.

with a large square notch on the anterior middle half, in which is seen the apical process already referred to (fig. 3, *a*). This notched cavity is bounded by a distinct ridge (fig. 4, *r*). The apical process (fig. 3, *a*) is now seen to be more or less almond-shaped, its centre being occupied by a similarly shaped cavity lined with delicate hairs (fig. 4, *b*). Separating this apical structure from the margin of the square cavity is, on each side, a row of 3 contiguous cup-like depressions, the posterior ones being more or less elongate (fig. 4, *p*).

These larvae feed immersed, but for their posterior process, in the slush, and are continually on the move. If disturbed they curl around any small obstacle that may be handy, and remain quiescent till the disturbing element is removed. The larval period extends into several weeks, but the total number of moults is uncertain.

The pupa rests embedded in the semi-liquid material on the surface of the slush, its two spiracles free to the air. Its power of movement is restricted, being able only to twist and twirl its abdomen to a slight extent, and it is quite unable to swim or otherwise care for itself. Like the larva, it varies in length, the longest being about ⅜ in. In colour it is yellowish-white; in shape elongate, but broad and rounded anteriorly, and narrowing considerably toward the terminal segment (fig. 5). There are 9 segments, each connected by a membranous intersegmental membrane, visible only when the body is fully extended. Anteriorly is

a pair of well-separated club-shaped two-jointed respiratory appendages (fig. 5, *ra*). One of these is shown greatly enlarged (fig. 6). Each one, excepting the first short joint, consists of a roughly ridged sheath (fig. 6, *sh*), the ridges extending over the whole surface, exclusive of the proximal ventral area, which is smooth. Along the ventral surface, and occupying the whole of the apex, are rows of numerous pits, the margins of which are raised above the level of the sheath. Within the sheath is a tracheal-like structure (fig. 6, *tr*).

Ventrally the folds of the 1st segment terminate in sharp convergent points at the centre of the posterior margin of the 3rd segment (fig. 5, *tf*). The inner margins of these folds—the wings—are ridged and separated by a set of 3 lobe-like structures - the limbs, *i.e.*, the 1st, 2nd, and 3rd pairs of legs—notched on the posterior margins, and possessing a medio-longitudinal fissure (fig. 5, *ls*). More anterior still, about the middle line of the first pair of ridges (the antennae) (fig. 5, *fr*), are a pair of ovate discs (fig. 5, *sp*), beset with numerous pits and short delicate hairs. The body segments from the 3rd to the penultimate are thrown into hollows and ridges, the posterior margins carrying an armature of stout reclinate spines (fig. 5), three of which (a central and two laterals) are considerably enlarged, and are borne upon protuberances. There are also 4 large and similarly formed discal spines. Dorsally the spines are less stout, less numerous, proclinate, the discal set being absent.

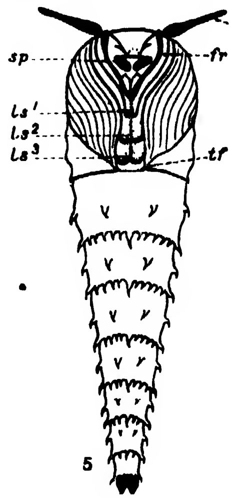
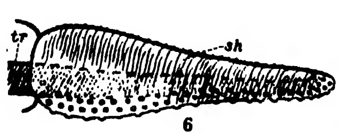


FIG. 5.—Pupa of *Psychoda conspicillata.* 1, 2, 3, 1st, 2nd, and 3rd pair of legs; *tf*, ventral extremity of wing-case; *fr*, antenna; *ra*, respiratory appendage; *sp*, ovate discs.

The apical segment has no discal or dorsal spines, but a half-whorl of stout claws.* Arising from this segment is the terminal appendage, consisting of 4 dorsally curved massive claws (figs. 7 and 8). The ventral pair are the smaller, and do not extend as far as the dorsal. Both the anterior and posterior appendages are dark brown.



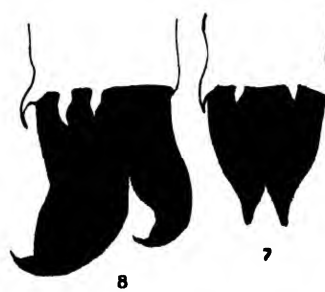


FIG. 6.—Respiratory appendage (greatly enlarged). *tr*, trachea; *sh*, sheath.
FIGS. 7, 8.—Terminal claws.

The duration of the pupal stage is four days.

The emergence of the adult fly is a most beautiful sight to watch through the low powers of a microscope. The pupa-case splits anterio-

* In fig. 8 these claws have been drawn on the dorsal instead of the ventral side.

dorsally, and a second later the perfect fly is outside and standing upon it. The wings begin to expand with a kind of uncurling movement, gradually extending outwards and up till they are held straight above the abdomen, their upper surfaces turned inward and together: then with a sudden relaxing motion they fall to their natural position across and on either side of the dorsum. The whole operation of emerging and drying the wings takes less than a minute. The fly is rather a sluggish insect, but quick of flight, and is often to be met with indoors. It is, however, harmless to man and beast, and probably destroys a great amount of unhealthy and decaying matter.

Hab.- Wellington (Hudson), Wanganui (M. N. W.); probably to be found in most parts of New Zealand.

"*P. phalaenoides*, Christchurch (Hutton). Auckland (Suter); introduced from Europe."

No. 6. Syrphus ropalus Walk.

Syrphus ropalus Walker, Cat. Dipt. Brit. Mus., p. 593 (1849): Hutton, Cat. Dipt. N.Z., p. 44; Trans. N.Z. Inst., vol. 33, p. 41.

The family to which this fly belongs is a very common one--Syrphidæ, or hover-flies and of great value from an economic point of view. As far as can be seen, nothing has been published concerning the habits and life-history of the present species. The egg stage is, unfortunately, still unknown, but may not differ very much from that of other flies of the same family, several of which are quite well known.

The larva is of a light-green colour, and attains a length of about ½ in. when full grown, and is greatly attenuated towards the head; it is soft-skinned and moist; the skin transparent, displaying clearly the whole alimentary system. Specimens were invariably found in the narrow spaces between the outer leaves of the heart of the cabbage-tree (*Cordyline australis*). The larva dislikes the light, and, when exposed, quickly makes off into the dark crevices between the leaves. The mode of progression is the same as in all other arboreal larvae of this family. It is a mystery how the blind larva finds his way, and is able to hunt out his prey, which in the present cases consists of the larvae of a Lepidopteron (*Venusia verriculata*) which also breed in the cabbage-tree. The reader is referred to No. 3 of this series of contributions for full notes on the breeding of this moth (Trans. N.Z. Inst., vol. 47, p. 268). It seems hardly likely that the prey is captured fortuitously. When a caterpillar is discovered, the larva, with a lightning toss of the head, plunges his beak into its body. The caterpillar will not submit quietly to this, but writhes and twists and twirls its body about, and even frequently attempts to bite its antagonist, sometimes in this way forcing the maggot to beat a hasty retreat. It is wonderful to see the way in which the larva sticks to his prey in spite of all the heaving convulsions; this he manages by ejecting a quantity of sticky mucus which practically cements him to the caterpillar. In the meantime, while the prey is still living, the maggot is rooting luxuriously amid its entrails, till nothing but the empty skin remains. The larval stage exists some length of time, probably several months. They feed on the larvae of *Venusia verriculata*, but in captivity also took readily to the larvae of another moth, *Tortrix postvittana*, which also feed in the head of the cabbage-tree, curling the tips of the leaves.

The pupa is tear-shaped; the posterior end, bearing the two respiratory tubes, is much flattened and constricted. Anteriorly it is much swollen, well rounded, and corpulent.

The colour is light brown, with a broad conspicuous dark medio-dorsal stripe extending the whole length of the pupa. On the sides are several (about 4) very faint narrow lines, much broken and interrupted, running

FIG. 9.—Pupa of *S. ropalus*.

parallel with the medio-dorsal. The integument is hard and roughened by numerous minute transverse rugae. Length of pupa,   breadth at posterior extremity, $\frac{1}{16}$ in.; at anterior end, $\frac{3}{32}$ in.

The pupa is to be found, as a rule, near the butts of the leaves, on the underside. The duration of this stage is about three weeks.

Hab. Auckland (Dr. Sinclair); Kekerangu, 3,000 ft. (Hudson); Dunedin (Hutton); Wanganui, October (M. N. W.); Marlborough, December (D. M.).

No. 7. **Phytomyza albiceps** Mg. Plates II and III.

As far as it has been possible to ascertain, this little fly has not till now been recorded from New Zealand. It is necessary, therefore, that a detailed description be included in the present paper.

The adult fly (Plate III, fig. 6) is small black in ground-colour, but with a covering of minute silvery-grey pubescence. Length of imago, ♂, 1 mm.; wing, 1·25 mm. Length of imago, ♀, 1·5 mm.; wing, 2 mm.

Eyes reddish-brown, broadly dichoptic, with minute scattered silvery hairs; vertex and front broad and yellowish, this colour (absent on the darker frontal lunule) being due to the presence of a dense and minute pubescence. On the front are a pair of parallel longitudinal depressions, assuming in certain lights an orange colour. Ocellar triangle dark reddish brown, more or less circular, the ocelli shiny dark orange and well separated. A pair of strong parallel proclinate ocellar bristles, one on each side of the anterior ocellus (fig. 10, *ob*); a pair of strong reclinate divergent post-ocellar bristles (fig. 10, *pob*) placed more closely than ocellar pair. Inner and outer vertical bristles strong, the latter divergent (*o*), the former convergent (*i*). A row of strong shorter post-orbital bristles (fig. 11, *po*) extending to lower margin of head; 3 strong reclinate upper fronto-orbital bristles (fig. 10, *ufo*); a single strong convergent frontal bristle (fig. 10, *f*); a row of smaller orbital bristles (fig. 10, *or*). *Antennae* inserted

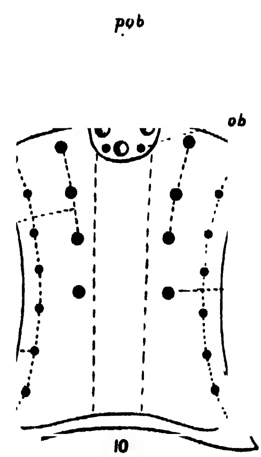
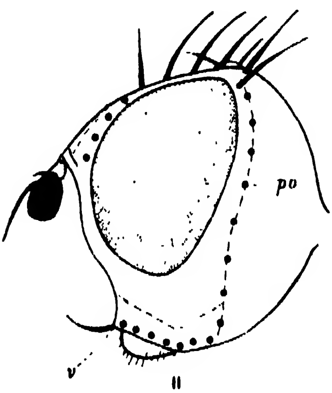


FIG. 10.—Dorsal portion of head of *P. albiceps*. *ob*, ocellar bristles; *pob*, post-ocellar bristles; *o*, outer vertical; *i*, inner vertical; *f*, frontal; *ufo*, upper fronto-orbital; *or*, orbital bristles.

at middle line of eye, three-jointed, slightly separated at the origin, not elongated, almost black, and covered with a short dense pubescence; 1st joint short; 2nd about half as long as 3rd, and bearing on the anterior margin a number of short bristle-like hairs, with a single strong bristle on upper anterior angle; 3rd joint orbicular in profile, but laterally flattened; arista dorsal, of moderate length, its 2nd joint short, the whole pubescent.

Face and cheeks yellow, the former depressed in front view but sinuated in profile (fig. 11); facial grooves extending well under the eye, are angulated before reaching the posterior orbital margin; vibrissae and vibrissal angles



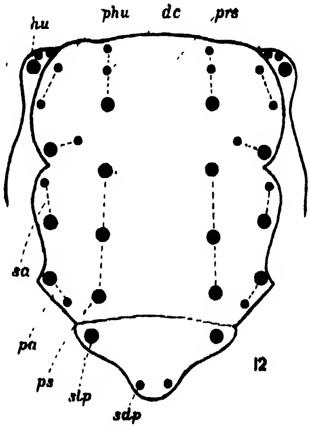


FIG. 11.—Lateral view of caput. *po*, post-orbital bristles; *v*, vibrissae and vibrissal angles.

FIG. 12.—Chaetotaxy. *hu*, humeral bristles; *phu*, post-humeral; *dc*, dorso-centrals; *prs*, pre-suturals; *sa*, supra-alars; *pa*, post-alars; *ps*, post-suturals; *slp*, scutellar lateral; *sap*, small apicals.

distinct (fig. 11, *v*); oral margin bristly, angulated, yellow, but darker in certain lights at the vibrissal angles; posterior orbits yellow, sinuated, broad, but narrower above; occiput rounded, piceous in certain lights. Proboscis withdrawn, yellow, and with a few yellowish hairs.

Thorax not elongate, black in ground-colour, with a minute grey pubescence; dorsum anteriorily humped in profile. Chaetotaxy (fig. 12): Dorso-centrals (*dc*) 3 in number, the 2 anterior small, the 3rd (towards the suture) large and distinct; a large humeral bristle (*hu*) and a few smaller ones; 2 small post-humerals (*phu*); 2 pre-suturals (*prs*), the outer large, the inner small; 3 large post-suturals (*ps*); 2 supra-alars (*sa*), the anterior small, the posterior large; 2 post-alars (*pa*), the anterior large, the posterior small. Scutellum with margin constricted, giving a sinuated and trilobed appearance; a large lateral bristle on anterior lobe near the suture (*slp*), and a pair of small apicals (*sap*). Four meso-pleural bristles, of which 2 smaller ones arise posteriorly along the dorso-pleural suture, a single large one at the upper posterior angle—that is, at the angle of the meso- and dorso-pleural sutures; just beneath this large one, on the meso-pleural suture, is situated the 4th smaller bristle; a single pro-pleural bristle; 3 small sterno-pleural bristles along the sterno-pleural suture, and a number of small ones upon the apex of this pleura.

Wings (fig. 13) moderately broad, colourless except for pale yellow at the articulation; when closed, extending considerably beyond the abdomen; costa (*c*) ending some distance from tip of wing; auxiliary vein (*aux*) indistinct, well separated from the 1st longitudinal vein, but evanescent distally;

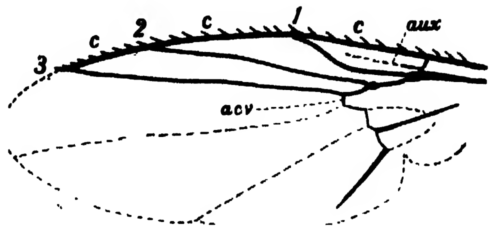


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FIG. 13.—Wing-venation, *P. albiceps.* 1, 1st longitudinal; 2, 2nd vein; 3, 3rd vein; *c*, costa; *aux*, auxiliary vein; *acv*, anterior cross-vein.

1st longitudinal (1) sinuated upward toward the costa; 2nd vein (2) only slightly sinuated; 3rd vein (3) uniting with the distal extremity of the costa; anterior cross-vein (*acv*) situated well before the middle of the wing and the end of the 1st longitudinal vein; posterior veins and basal cells indistinct. Halteres pale yellow.

Legs bristly, black with pale-yellow knees; femora comparatively thickened; tibiae shorter than the femora; tarsi considerably longer than either the femora or tibiae, the metatarsi being about one-third the length of the whole tarsal joint; 2nd tarsal joint about one-half the length of the metatarsus; claws small, pale yellow on proximal half, but black distally, the inner proximal angle of each protruding knob-like; pulvilli pale yellow, with a vestiture of delicate hairs; empodium a strong bristle; a small apical bristle on inner angle of middle tibiae; anterior femora with longer bristles on the lower side.

Abdomen about as long as the thorax, but not as broad, narrowing toward a rounded apex; black in ground-colour, but with a minute greyish pubescence. When ventrally examined the genital cavity is heart-shaped, the margin being beset with short bristles, from among which protrude the pale-yellow copulatory organs.

The female fly appears to deposit her ova on both surfaces of the leaves of the food plant. Close observations show that the upper side is almost invariably preferred, the majority of eggs being laid on the outer margin of the leaf. Having selected a suitable spot for oviposition, the fly lowers her ovipositor till it is at right angles to the surface of the leaf, having to stand on tip-toe for the purpose; with several downward jerks of the abdomen the ovipositor is thrust through the cuticle and pushed beneath its surface, pushing at first directly backwards and later laterally, in this way prizing up the cuticle so as to form a minute semicircular pocket in the leaf (Plate III, fig. 1). After a moment's rest the ovipositor is withdrawn, leaving a single egg within the pocket. Some little time after the cavity has been made the separated cuticle dries, and the whole becomes visible to the naked eye as a minute white spot on the leaf.

While engaged in laying, the fly is very sluggish, and can be closely observed with a magnifying-glass without taking to flight, and can even

be gently transferred from one leaf to another; it is, however, extremely rapid of flight. Almost invariably on the withdrawal of the ovipositor from the leaf the fly will immediaetly turn and eagerly lap the exuding sap. Whether this is merely to satisfy her own immediate wants or is in some way connected with the welfare of the egg is from data in hand a debatable point. Before continuing the process of laying the ovipositor and body generally are subjected to a thorough cleansing: all extraneous matter is removed. The egg-laying capacity of any individual probably reaches about 200 ova.

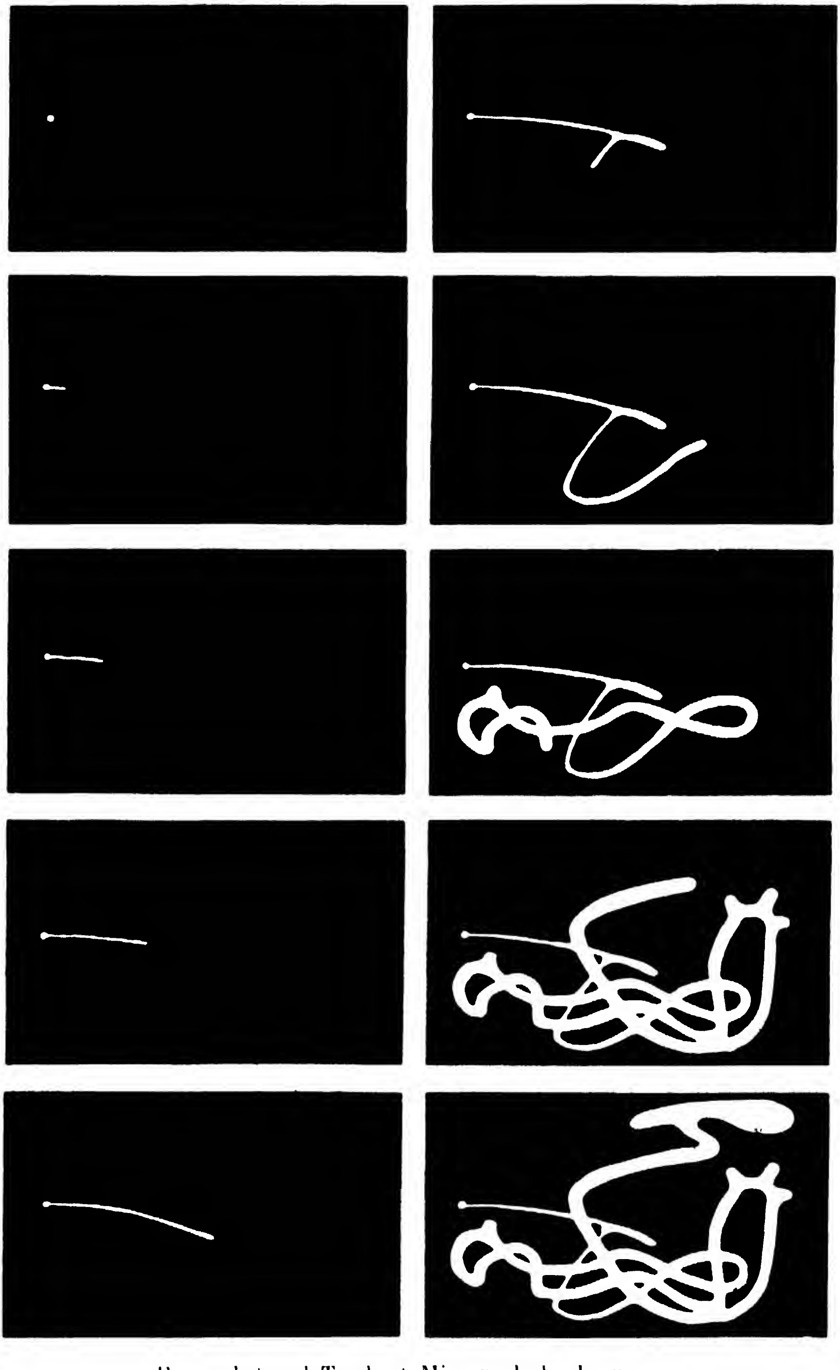
Often cavities that have been carefully probed will be left without an egg. This is hard to explain; probably at the moment the ovum was not ripe within the ovaries. Pockets might be begun in tough portions of the leaves, but in such places they are hardly ever completed, and no eggs are deposited in them. The time taken in probing a cavity and depositing the egg rarely exceeds a minute. During the proceedings the back legs are at times violently stamped upon the leaf. Occasionally leaves are found crowded with these pockets, but in such cases only a few of them will contain eggs.

The ovum is cylindrical, pearly-white, glossy, ends rounded; the shell is very delicate, and devoid of any kind of sculpturing. The micropylar (?) end is slightly broader than its nadir. Length, 0·32 mm.; greatest diameter, 0·15 mm.

The larva (Plate III, fig. 2) hatches on the sixth day after the laying of the egg. It at once begins burrowing in the soft inner substance of the leaf, keeping close against the upper cuticle. Burrowing now goes on unceasingly for the next nine days. The mine often assumes fantastic forms, sometimes crossing and recrossing itself many times; as the larva grows, the mine, of course, gradually widens and becomes very conspicuous as a white figure upon the green leaf. A thin line of minute frass granules occupies the middle portion of the floor of all mines. During the last three days the larva pushes ahead with great rapidity, as a glance at Plate II will show. The following figures are from another mine that was kept under careful observation: Distance pierced by larva during the first day of its larval existence, $\frac{1}{8}$ in.; second day, $\frac{1}{4}$ in. in all; third day, $\frac{1}{2}$ in.; fourth, $\frac{3}{4}$ in.; fifth, $1\frac{1}{2}$ in.; sixth, 2 in.; seventh, 3 in.; eighth, 5 in.; ninth, $7\frac{3}{4}$ in.—total length of mine.

The larva (Plate III, fig. 2) is a minute cylindrical grub, broadest near the head; white in colour, inclining to light green on account of the assimilated food within the intestines and the transparency of the skin. The head is to a certain extent retractile. The following measurements are from a full-grown larva: Length, 3·0 mm.; greatest breadth, 0·9 mm. Posteriorly there are two minute black respiratory processes; a second pair, situated anteriorly on the head, are slightly longer, and white.

The mouth-armature of the adult larva differs sufficiently, on account of the mode of feeding, from that of other dipterous larvae to warrant a detailed description. It consists of two horizontal plates connected by a slender cross-bar; these are the cephalo-pharyngeal apophyses. Each consists of three processes—an anterior (fig. 14, *a*), narrowing towards the great hooks; a posterior (*p*), broadening slightly towards the extremity; and a mid-lateral process (*ml*), which is spinular, and directed posteriorly. The two great hooks, placed side by side, present three processes—a large anterior curved sickle-like process, a like but smaller mid process, and a broad blunt triangular heel. The whole cephalo-pharynx is deeply



Egg-pocket and Track of Mine made by Larva.

Phytomyza albiceps

Face p. 282].

pigmented, black, excepting the mid-lateral processes, which are lighter in colour. The hooks are directly connected with the mouth, and are used horizontally to scoop the inner substance of the leaf. In all carnivorous larvae, on the other hand, the great hooks are utilized merely as a means of travelling, and are not in direct communication with the mouth.

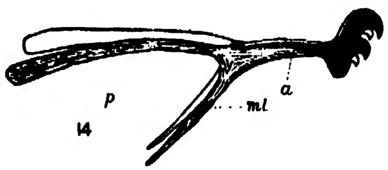


FIG. 14.—Mouth-armature of larva, *P. albiceps*. *a*, anterior process; *p*, posterior process; *ml*, mid-lateral process.

A day prior to pupating the larva forsakes the upper surface and commences burrowing against the lower cuticle of the leaf, scooping out a chamber for itself. The following observations are of interest: Out of a total of 659 mines observed, ninety-one larvae had hatched, mined, and pupated in the upper portion of the leaf, while no less than 521 had descended to the lower surface to pupate. Still more significant is the fact that thirty-six that had been laid on the under-surface had remained to pupate there, while six had come to the upper surface to mine but had descended to the lower cuticle to pupate. Five only hatched on the lower portion of the leaf and pupated on the upper. This clearly demonstrates the presence of some special sense in the larvae unknown to us.*

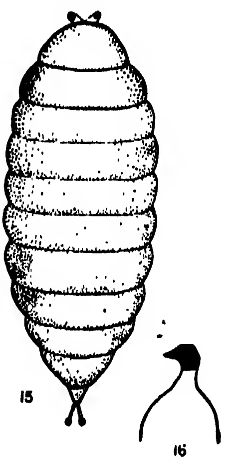


FIG. 15.—Pupa of *P. albiceps*.
FIG. 16.—Anterior process.

The pupa (fig. 15) is destitute of hairs or bristles; is dark-brown; not elongate and narrow, but moderately stout; composed of 10 segments, exclusive of the light-brown tubercles bearing the anterior and posterior appendages. In most healthy pupae the colour is light brown, with a darker medio-dorsal line. The hairs and limbs of the fly within can be clearly distinguished a few days before emergence. The dorsal surface is more or less flat, the ventral slightly convex, while the anterior end is rounded and the posterior pointed when viewed dorsally. Anteriorly the dorsal and ventral lines run about parallel—lateral view—but posteriorly the ventral line is distinctly upturned toward the posterior processes, which, unlike the anterior, arise toward the dorsal line. When the pupa is at rest beneath the lower leaf-

* Several experiments have been carried out since writing the above. Leaves of the food plant containing nearly full-grown larvae burrowing beneath the upper cuticle were placed the right and the wrong way up on damp blotting-paper in shallow glass petri dishes. When the leaves were kept exposed to the ordinary light of the room the larvae pupated in the lower portion of the leaf, whether that happened to be the natural under-surface or not. In complete darkness they, almost without exception, pupated on whatever surface they were burrowing at the commencement of the experiment, oblivious of the fact that the leaves were in many cases the wrong way up. One may safely say, then, that these larvae are influenced by light, and pupate in that portion of the leaf where they will get the most shade. How they are influenced by light remains to be seen.

membrane of the food plant the posterior processes (Plate III, fig. 5) are extruded through the cuticle of the leaf, while the anterior pair, situated as they are toward the ventral line, are embedded in the tissues of the leaf. When viewed laterally under the microscope an anterior process (fig. 16) is seen to consist of a dome-shaped body terminating in a black knob-like head, the lower margin of which is drawn out to a point. Immediately above the anterior process is a pair of contiguous lobes distinguished by a central fissure. Each posterior process consists of a light-brown stalk terminating in a rounded dark-brown head. The pupa, when at rest beneath the leaf-membrane, is easily seen with the unaided eye, but under the microscope presents a unique appearance, due to the cellular structure of the leaf (Plate III, fig. 3). A photograph of the exposed pupa is shown in Plate III, fig. 4. Length of pupa, 2 mm.

Two minute hymenopterous parasites attack this fly, and are very common. They belong to the *Chrysocharis* sp., but neither are as yet further identified. The larger of the two was seen ovipositing in a newly hatched larva of *P. albiceps*, the membrane of the leaf evidently being pierced in the process. Apparently the larva of this parasite lives in the larva and pupa of its host, for specimens were always obtained from infected pupae of the fly. One can tell at a glance whether a pupa is infected or not, since those containing parasites are black and opaque, and are a great contrast to the rich brown and semi-transparent pupae of healthy flies. It appears that not more than one Hymenopteron is reared from any one host.

The smaller of the two parasites has now several times been seen ovipositing in the pupae of *P. albiceps*, often walking over and completely ignoring living larvae. As such pupae were in each case observed infested with the larger parasite, it may be quite possible that this smaller species is in reality a true hyperparasite. A full account of the lives, habits, and life-histories of these two *Hymenoptera* will form the subject of some future contribution.

Food Plants of Phytomyza albiceps.

The common sowthistle (*Sonchus asper*) is the favourite food plant. Also found plentifully on *S. oleraceus*, and *S. arvensis*. Has been found burrowing in dahlia, dandelion (*Taraxacum officinale* var. *glabratus* (?)), large nettle (*Urtica ferox*), Cape-weed (*Cryptostemma calendulacea*), common groundsel (*Senecio vulgaris*).

Hab.—Wanganui, October to April (M. N. W.); Whakamarina, December (D. M.).

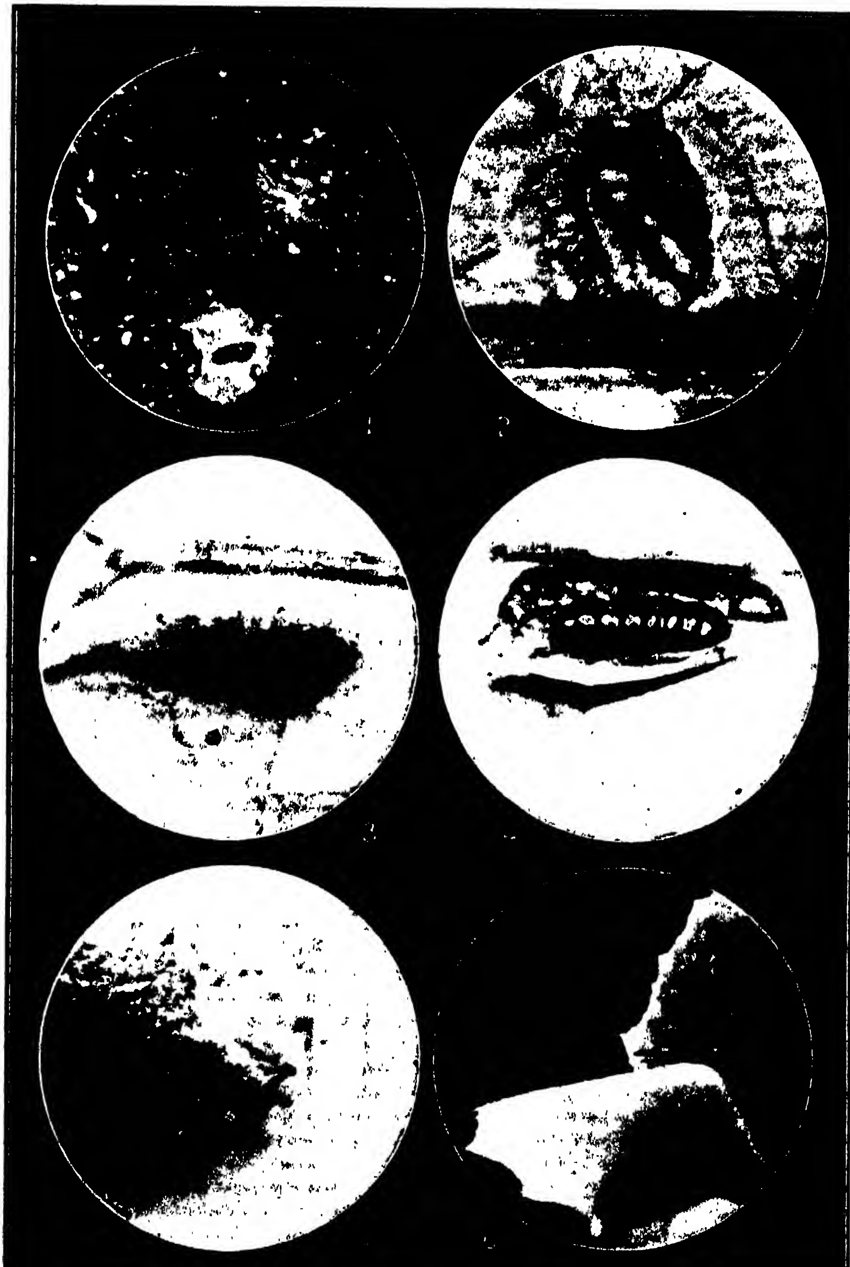
EXPLANATION OF PLATES.

PLATE II.—*Phytomyza albiceps* Mg.

Showing egg-pocket and track of mine made by the larva during the nine days of its larval period. (Note the progress during the last three days.)

PLATE III.—*Phytomyza albiceps* Mg.

Fig. 1. Egg-pocket in leaf. The egg is visible under the thin cuticle of the leaf. (Note the empty pocket above.) × 18.
Fig. 2. Larva, full-grown, uncovered. × 14.
Fig. 3. Pupa beneath cuticle of leaf. × 14.
Fig. 4. Pupa exposed (lateral view). × 14.
Fig. 5. Posterior respiratory processes of pupa pushed through the cuticle of the leaf. × 56.
Fig. 6. *Phytomyza albiceps*. Photographed from life. × 2.



Phytomyza albiceps.

Face p. 984.]

ART. XXX.—*Pedunculate* Cirripedia *of New Zealand and Neighbouring Islands*.

By L. S. JENNINGS, M.Sc.

[*Read before the Canterbury Philosophical Institute, 2nd December, 1914.*]

THE objects of this paper are—(1) to give a reliable list of stalked barnacles collected from the New Zealand region; (2) to discuss the characters which are at present regarded as specific in the cases of *Lepas anatifera* and *Pollicipes darwini*.

The specimens the work is based on belong to the only two important existing collections in New Zealand that I am aware of—viz., that of the Otago Museum, which includes Captain F. W. Hutton's original collection, and my own collection at the Biological Laboratory, Canterbury College, which includes a large amount of material collected and in some cases already described by Dr. Charles Chilton.

The works of reference I have made most use of are—(1) Darwin, C. (1851), "Monograph on the *Cirripedia: Lepadidae*"; (2) Hutton, F. W. (1879), "List of New Zealand *Cirripedia*," Trans. N.Z. Inst., vol. 11, p. 329; (3) Gruvel, A. (1905), "*Cirrhipèdes*"; (4) Pilsbry, (1907), "Barnacles of the United States National Museum"; (5) Chilton, C. (1911), "*Crustacea*, Trawling Expedition, 'Nora Niven,'" Records Canterbury Museum, vol. 1, No. 3, p. 311; (6) Chilton, C. (1911), "Dispersal of Marine *Crustacea* by Means of Ships," Trans. N.Z. Inst., vol. 43, p. 132; (7) Chilton, C. (1911), "*Crustacea* of the Kermadec Islands," Trans. N.Z. Inst., vol. 43, p. 571.

I. LIST OF PEDUNCULATE CIRRIPEDIA.

[Those marked * are to be found in the Otago Museum; the rest are in my collection at the Biological Laboratory, Canterbury College, Christchurch.]

The following is a complete list of pedunculate *Cirripedia* gathered from the region of New Zealand and the surrounding islands (Auckland, Campbell, Chatham, and Kermadec Groups) up till December, 1914. In this list I have included only those species of which I have been able to examine specimens definitely known to occur at the localities mentioned.

1. **Lepas anatifera** Linnaeus.

General type: Kermadec Islands; collected by Oliver, 1908. Var. (*b*) *dentata* Darwin: Kermadec Islands; Oliver, 1908. Var. (*c*), new variety: Kermadec Islands; Oliver, 1908, and Bell, 1909–10: Chatham Islands: Miss Shand, 1910: "Terra Nova" hull, Lyttelton, November, 1910.

2. **Lepas australis** Darwin.

New Brighton and Sumner, New Zealand; common. *Waikouaiti, Otago; attached to penguin's foot. "Terra Nova" hull, Lyttelton, November, 1910.

3. **Lepas fascicularis** Ellis and Solander.

New Brighton, New Zealand; Dr. Dendy, 1895. Kermadec Islands; Oliver, 1908. *The Nuggets, Otago; and North Cape, Auckland.

4. **Lepas pectinata** Darwin.

General type: Chatham Islands; Dr. Dendy, 1901. Var. (*a*) Darwin: Kermadec Islands; Oliver, 1908. *North Island, New Zealand (dry).

5. **Lepas denticulata** Gruvel.

Kermadec Islands; Captain Bollons, 1907.

6. **Pollicipes sertus** Darwin.

Kaikoura, New Zealand, 1898; Port Pegasus, Stewart Island, 1907; Oamaru, 1914.

7. **Pollicipes spinosus** Quoy and Gaimard.

Kaikoura, New Zealand, 1898; Taylor's Mistake Bay, Lyttelton, New Zealand: *Wellington; F. W. Hutton (dry).

8. **Pollicipes darwini** Hutton.

*Dunedin A. Montgomery (type), (dry). *St. Clair, Dunedin; F. W. Hutton. Port Pegasus, Stewart Island, 1907; Kaikoura, Oamaru, Dunedin, 1914.

9. **Scalpellum (Smilium) spinosum** Annandale.

*Farewell Spit, Nelson, Annandale. "Nora Niven" Expedition, Station 5, 1907.

10. **Scalpellum villosum** Leach.

Port Robinson, Marlborough, 1910; Oamaru, 1914; *St. Clair, Dunedin.

The above list is as complete as I can make it, and contains all that can be considered absolutely reliable material as regards identity and locality so far collected. Except in the three cases noted, the specimens are all well-preserved spirit ones, and located in the Otago University Museum, Dunedin, or in the Biological Laboratory, Canterbury College, Christchurch. I have carefully dissected several specimens of each of the species given, and examined all the main points of identification, including the mouth parts, and have repeated my work at intervals of several months. I am reasonably certain, therefore, that the specimens handled should be referred to these species as at present constituted, and described by Darwin (1851) and Gruvel (1905).

There is a large amount of material which should be recorded here, but which must be kept out of the reliable list for this region. Thus, I have examined well-preserved spirit specimens belonging to the following species, but have not included them in the list given above, as the locality is doubtful and it is not certain that they are indigenous to the New Zealand region:—

1. *Lepas anatifera* Linnaeus.

General type: Canterbury Museum; locality unknown. *Otago Museum, "Ship's bottom, 1905."

As noted in the list above, this species has been collected at the Kermadecs and at Chatham Islands, but it is not certainly known to occur in New Zealand proper.

2. *Lepas hillii* Leach.

"Terra Nova" hull, Lyttelton, 1910.

3. *Conchoderma aurita* Linnaeus.

"Terra Nova" hull, Lyttelton, 1910. *Otago Museum and Auckland Museum, attached to whale.

4. *Conchoderma virgata* Spengler.

"Terra Nova" hull, Lyttelton, 1910. *Ship's hull, Dunedin.

5. *Lithotrya dorsalis* Sowerby.

Canterbury Museum; locality unknown.

6. *Ibla quadrivalvis* Cuvier.

Canterbury Museum; locality unknown.

I have included specimens obtained from the "Terra Nova" in my reliable list only when the species from other information is definitely known to occur in the New Zealand region. The "Terra Nova" was Captain Scott's Antarctic exploring vessel, with a wooden hull. Her route from England to New Zealand was via Cape Town, Hobart, and Melbourne, and the specimens were gathered shortly after her arrival in Lyttelton in October, 1910.

In addition to the above well-preserved material, there are dry specimens, mounted on cardboard, in my collection and in the museums throughout New Zealand. They are not of much value in this connection, and do not add to the list. Hutton's type specimen for his new species *Pollicipes darwini* is unfortunately in this condition. It was briefly described on external characters only, and never figured.

It is hoped that this list will form a reliable foundation for additions to the group, which are certainly to be found in this region. So far it has been very imperfectly explored, and the material already collected has often been wrongly named, owing to the difficulty of the classification.

NOTE.—Hutton's list of New Zealand pedunculate *Cirripedia* (1879) is as follows: *Lepas hillii*, *Lepas pectinata*, *Lepas australis*, *Lepas fascicularis*, *Scalpellum villosum*, *Pollicipes spinosus*, *Pollicipes darwini*.

The identity of the specimens identified by Hutton as *L. hillii* is not certain now. They are dry, rather small, with no umbonal teeth, and a carina not strongly forked. As will be seen in the following section, this is not sufficient to distinguish them from certain forms of *L. anatifera* and *L. australis*. The filaments would decide the matter, but these cannot be made out from the shrivelled animals. There is no certain evidence of *L. hillii* yet having been collected from the New Zealand region.

II. A Discussion of the Specific Characters of Lepas anatifera Linnaeus.

Lepas anatifera Linnaeus, 1758.

1851. Darwin, "Monograph *Cirripedia: Lepadidae*," p. 73.

1905. Gruvel, "*Cirrhipèdes*," p. 108.

1907. Pilsbury, "The Barnacles of the United States National Museum," p. 79.

This species includes—(1) the general type; (2) var. (*a*) *punctata* Darwin; (3) var. (*b*) *dentata* Darwin; (4) var. (*c*), new variety.

The general type has—(1) a distinct umbonal tooth on the right scutum only; (2) two well-developed filaments on each side of the body.

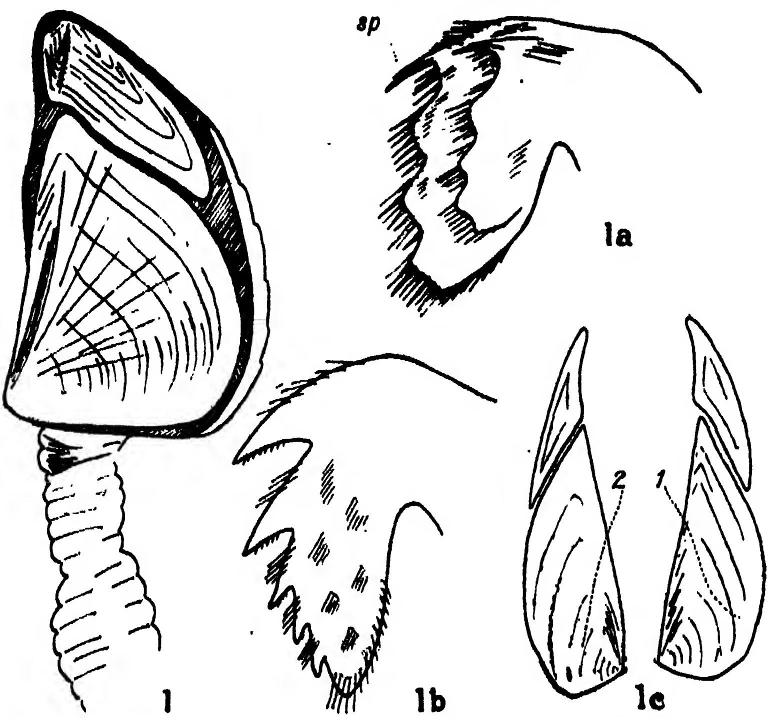


FIG. 1.—*Lepas anatifera* var. (*c*), new variety. Kermadec Islands (Bell), 1909–10. External view, right side. Length of capitulum, 33 mm.; width of capitulum, 21 mm.; length of peduncle, over 100 mm.

FIG. 1*a*.—Maxilla of same specimen. *sp.*, two prominent spines. Length (from top to bottom), 2 mm.

FIG. 1*b*.—Mandible of same specimen. Length (from top to bottom), 3 mm.

FIG. 1*c*.—Opercular valves of same specimen, viewed along occludent margin. 1 Right scutum; 2 left scutum.

Var. (*a*) *punctata* has, in addition, square patches across the capitulum. Var. (*b*) *dentata* has, in addition to the characters of the general type, a strongly barbed carina. Var. (*a*) has not been collected in the New Zealand region. The others have

The main characters of var. (*c*) need setting down. They are quite definitely as follows: (1) No trace of an umbonal tooth on either scutum;

(2) two well-developed filaments on each side of the body. The carina is not barbed, and square patches on the capitulum are not visible. In size and remaining characters it is indistinguishable from the general type.

The numerous specimens of this variety, collected as mentioned in the first part of this paper, all agree distinctly with *L. anatifera* Linn., general type, of which excellent specimens were also obtained from the Marine Biological Laboratory, Plymouth, England, for purposes of comparison, with this uniformly exceptional character: that there is no trace of an umbonal tooth on either scutum. The umbonal angles may be slightly incurved, their apices may sometimes slightly overlap, but there is no more definite tooth than in *L. hillii*, and nothing approaching the distinct tooth of the general type of *L. anatifera* nor the distinct teeth of *L. australis*.

Possible confusion of *L. australis* and *L. anatifera:* The wide forking of the carina below the basal margin of the scuta, and the umbonal tooth on each scutum, would ordinarily allow one to recognize *L. australis* from this new variety. But I have specimens among others undoubtedly *L. australis* in which the prongs of the carinal fork are scarcely developed, and no more than an incurving occurs at the umbo of either scutum. I have decided that these are immature specimens of *L. australis:* the carinal fork is undeveloped and the penis does not project through the cirri. They were collected alive in midsummer, were apparently full size, and contained ova. I have specimens from the same lot showing in gradation just one small tooth on the right scutum, and then the two small teeth accompanied by a wider forking of the carina and lengthening of the penis. I think the view of immaturity is therefore a correct one. All have the two distinct filaments on each side of the body.

FIG. 2.—*Lepas anatifera* Linnaeus general type. Marine Biological Laboratory, Plymouth. Opercular valves. 1, Right scutum; 2, left scutum; 3, umbonal tooth. Length of capitulum, 34 mm.

One can easily see that a slightly immature specimen of *L. australis* could be selected which the specific characters as at present given in the standard works quoted would fail to distinguish from *L. anatifera* general type or *L. anatifera* var. (*c*) new var. Only a collector familiar with general appearances could distinguish them, and he would have a difficulty in basing his distinction on constant characters. He would have to fall back on the curvature of the occludent margin, the thinness of the valves, and possession of 3 prominent spines at the upper angle of the maxilla, which seem fairly constant.* The adult *L. australis* is, however, apparently the certain possessor of 2 distinct umbonal teeth and a specially wide carinal fork, and therefore can be readily identified. The point is, can *L. anatifera* var. (*c*)

* (1.) Most maxillae of *L. antifera* and *L. hillii* have 1 or 2 prominent spines at the upper angle. (2.) Further, without dissection, or if the specimen were dry, it appears impossible to state definitely whether certain forms are *L. australis*, *L. hillii*, or *L. anatifera*. The dry specimens of these in the museums are, therefore, scarcely reliable.

new var. be immature forms of the general type, and the non-development of the umbonal teeth be thus accounted for? It seems certainly not possible. The umbonal teeth are uniformly absent in fully developed forms down to the smallest. And in *L. anatifera* general type the tooth is uniformly present from the smallest to the best-developed specimens. This ensures that the new variety is not an immature form of *L. anatifera* general type nor of *L. australis*.

This new variety of *L. anatifera* next affects the present classification and distinction of *L. anatifera* and *L. hillii*. The latter is known by—(1) no umbonal teeth on either scutum; (2) 3 filaments on each side of the body.

In other respects, including the mouth parts, it is closely similar to the general type of *L. anatifera*. The maxillae and mandibles in all the varieties of *L. anatifera* and in *L. hillii* are practically indistinguishable. I have put my new variety under *L. anatifera*, rather than under *L. hillii*, because the former is a most widely distributed species, and because an external umbonal tooth seems more likely to vary than a filament. The calling of this new variety a new species would have certainly nothing to justify it. What is left is to regard the following specific characters now as certainly distinctive:—

L. anatifera: 2 filaments; umbonal teeth absent or on right scutum only.

L. hillii: 3 filaments; umbonal teeth absent.

L. australis: 2 filaments; umbonal teeth on each scutum in adult; and the following small, fairly reliable characters: wide carinal fork, brittle valves showing curved occludent margin, and 3 spines on maxilla.

Any one can then distinguish the known specimens of these without the confusion and difficulty at present attending their classification.

When preserved in spirit, certainly all three species are very similar in size and general appearance.

The other members of the genus will give little difficulty.

As for other characters often given, I know of no others certainly distinctive. I have specimens from each of the three species which show that (*a*) radiating lines on the valves, (*b*) proximity of carina to the other valves, (*c*) apex of carina being rounded or acuminate, (*d*) the distance the carina extends up between the terga, and (*e*) the curvature of the occludent margin, cannot be used as accurate guides in distinction. The great variability of all these characters in specimens I have examined belonging to *L. anatifera* alone makes them of little use in distinguishing *L. hillii* and *L. australis*.

It will be seen, then, that such statements as the following now require modification:—

(1.) "The smoothness of the valves, together with the presence of a tooth on the right-hand scutum, and its entire absence on the left-hand side, is an unfailing diagnostic mark" of *L. anatifera*. (Darwin, "Monograph *Cirripedia: Lepadidae*," p. 77.)

(2.) *L. anatifera* "*Carène séparée des autres plaques par un espèce membraneux très étroit ou nul.*" (Gruvel, "*Cirrhipèdes*," p. 108, 1905.)

(3.) *L. anatifera:* "It resembles *L. hillii*, but may be distinguished by the faintly striated valves, the presence of an umbonal tooth in the right scutum, none in the left, and the proximity of the base of the carina to the scutum." (Pilsbry, "Barnacles of United States National Museum, 1907.)

III. The New Zealand Species of Pollicipes.

The species of this genus recorded for New Zealand are:—

1. **Pollicipes spinosus** Quoy and Gaimard, 1834.
   1851. Darwin, "Monograph *Cirripedia: Lepadidae*," p. 324.
   1879. Hutton, "List of New Zealand *Cirripedia*," Trans. N.Z. Inst., vol. 11, p. 329.
   1905. Gruvel, "*Cirrhipèdes*," p. 20.

2. **Pollicipes sertus** Darwin, 1851.
   1905. Gruvel, "*Cirrhipèdes*," p. 22.

3. **Pollicipes darwini** Hutton, 1878.
   1905. Gruvel, "*Cirrhipèdes*," p. 21.

These three species belong entirely to New Zealand. Just as the bulk of *Lepas* forms met with in New Zealand will come under the three species already treated, so the bulk of New Zealand *Pollicipes* will be referred to these three; and, with the present descriptions of them also, the classification of the forms is a complicated puzzle.

The distinct characters, taken from Darwin and Gruvel, are: For *P. spinosus*—(1) yellow membrane covering the valves; (2) rostrum short, wide, and curled inwards; (3) apex of carina not projecting, and terga not rising much above the scuta: for *P. sertus*—(1) dark red-brown membrane; (2) rostrum longer and more projecting; (3) apex of carina projecting, and terga not rising much above the scuta.

Then, according to Hutton's description, *P. darwini* is "easily distinguished from *P. spinosus* by the projection of the terga beyond the scuta, and from *P. sertus* by the short rostrum and apex of carina not projecting."

The history of these species is briefly this: Darwin (1851) recognized from New Zealand specimens *P. sertus* and *P. spinosus*. Hutton (1878), when living in New Zealand, added *P. darwini*; it appears in his list of New Zealand *Cirripedia*, with a brief description of external characters, not accompanied by drawings. Gruvel (1905) described *P. sertus* and *P. spinosus*, and includes *P. darwini*, but questions it, suggesting it to be a variety of *P. sertus*: "*Cette espèce semble très étroitement unie a* P. spinosus *et surtout a* P. sertus . . . . *Nous avons rencontré un* Pollicipes, *répondant à tous ces caractères provenant de l' 'Astrolabe' et nous n'avons pu le distinguer de certaines formes de* P. sertus. Pollicipes darwini *ne serait-il qu'une variété de forme de* P. sertus?" ("Cirrhipèdes," p. 21.)

I have examined carefully hundreds of forms of these species. They occur by the thousand in the dark crevices of rocks between high-tide and half-tide mark. I have gathered them from Kaikoura, from Oamaru, and from St. Clair, Dunedin, the last place being the locality from which Hutton obtained his specimens. They are very common, but are easily overlooked, since the black and white of the rocks exactly matches the black peduncle and the white worn valves. No explanation has been offered of this as a protective resemblance. I have also examined the specimens labelled by Dr. Dendy, Canterbury College, as *P. spinosus*, and those labelled by Captain Hutton as *P. spinosus* and as *P. darwini*.

The great majority have the valves much worn and variously worn. These are the forms which have been classified as *P. spinosus* and *P. darwini*,

the distinction being in the height the terga rises above the scuta. But from the wearing received, not only will this character be found highly variable, but also other external characters relied on in the classification, including (*a*) the size of the rostrum and its projection, (*b*) the projection of the carinal apex, (*c*) the size of the valves and the number of lateral plates developed. Taking this into account, I could see no valid distinction between the specimens labelled by Hutton *P. spinosus* and *P. darwini*, when placed side by side.

But there were in my original collection, and I found others by careful search in the rocks, a few specimens from sheltered positions with the

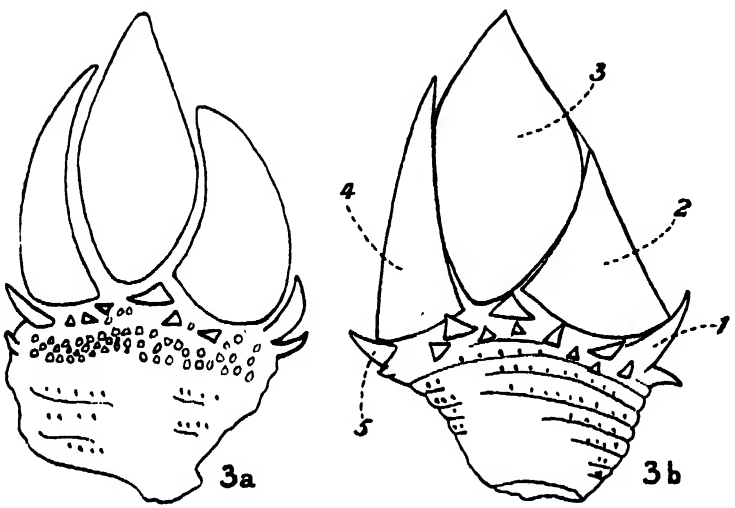


FIG. 3*a*.—*Pollicipes darwini* Hutton. Type specimen, dry and worn. Diagram showing shape and position of plates. Height of specimen, 27 mm.; width, 19 mm.

FIG. 3*b*.—*Pollicipes* sp. Well-preserved immature form, with the characters of *P. sertus*. Height, 19 mm.; width, 13 mm. 1, Rostrum; 2, left scutum; 3, left tergum; 4, carina; 5, subcarina.

points of the valves and plates sharp and the surfaces uncorroded. They are mostly immature, but there is an occasional full-sized one. If these were examined independently they would certain be classed as *P. sertus*. They have the distinctly projecting rostrum and carinal apex. I have figured one in fig. 3*b*. They are found amongst the very common worn specimens which, I have not the slightest hesitation in stating, after examining his type and visiting the locality where he obtained them, are what Hutton meant to distinguish as *P. darwini*.

Yet, beginning with these well-preserved forms, can be found practically all stages leading by growth and wearing into the common form.

I am practically convinced that there is only one species in all these New Zealand *Pollicipes*, whose external characters get highy modified by wearing; that it is the young and well-preserved forms of it which have been called *P. sertus;* that the somewhat worn specimens, with therefore a shorter and wider rostrum, apex of carina not projecting, apex of terga not rising much above apex of scuta, and a good showing of lateral plates and spines, are those which have been called *P. spinosus;* and that the

average worn specimens, at the most distinguished from the last by the prominence of the terga, have been called *P. darwini*.

I could readily find specimens, I believe, from the same bunch, certainly from the same locality, to match each of these species. However, since these species are at present accepted, I have included all three in my list.

In addition, I have examined the mouth parts from a number of representative specimens. So far I have found the mandibles and maxillae rather variable, and not uniformly so.

As for the colour on the membrane covering the peduncle and valves, those that have been some years in spirits are yellow; fresh specimens are blackish; dried ones grade from black to dark brown to yellow. All varieties when first put into methylated spirits turn quickly red. The colour differences given by Darwin and Gruvel would scarcely, then, seem to afford any valid distinction of species.

To conclude, I am practically certain that the New Zealand *Pollicipes* so far recorded come under one species only, which, by priority, should be called *Pollicipes spinosus* Quoy and Gaimard.

ART. XXXI. *The Occurrence in New Zealand of* Myriapoda *of the Genus* Scutigerella, *Order* Symphyla.

By GILBERT ARCHEY, M.A., Assistant Curator, Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 2nd December, 1914.*]

THE group *Symphyla* is of considerable interest and importance, for, as its name, given so appropriately by Ryder,* implies, it forms a connecting-link between two classes of animals—the *Insecta* and the remainder of the *Myriapoda*. The characters which indicate insectan affinities are the number and arrangement of the mouth-parts, and the presence, at the base of the legs, of small processes called exopods. The insects which show these characters are the simplest and most primitive groups—*Thysanura* and *Collembola*—a significant fact, for similarity of structure in primitive, unspecialized forms of two groups is more likely to indicate affinity than resemblances in highly specialized and otherwise extremely differentiated forms.

The *Symphyla* contain two genera, *Scolopendrella* and *Scutigerella*, the species of which have been found in most parts of the world, but not hitherto from either Australia or New Zealand. Dr. H. J. Hansen, of Copenhagen, who has written a monograph on the *Symphyla*,† stated in a letter, dated 2nd November, 1903, to Dr. Chilton that he had had no specimens from New Zealand or Australia, and suggested that search would show that several forms of *Symphyla* would certainly be found in both of these countries. Dr. Hansen's opinion has now been confirmed as far as New Zealand is concerned.

The specimen I am describing in this paper was among some *Myriapoda* from Ben Lomond, Lake Wakatipu, collected by Mr. T. Hall, and forwarded

* Ryder, F. A. Amer. Naturalist, vol. 14, pp. 821, 822, 1880.
† Hansen, H. J. Q.J.M.S., vol. 47, pp. 1–101, pl. 1–7, 1904.

to me by Dr. Chilton. It agrees very closely with the description given by Hansen (*loc. cit.*) of *Scutigerella caldaria* Hansen, but differs in the number of joints of the antenna. This will be referred to in the description given below.

Scutigerella caldaria was described from specimens found in hothouses in Copenhagen and Paris. Dr. Hansen had specimens of this species from South America also, and he states (*loc. cit.*) that the South American specimens very probably belong to the original form from which the specimens in the European hothouses have descended.

The presence of the same species in New Zealand also is another of the now fairly numerous examples of an animal whose means of distribution are limited being found in New Zealand and South America, and is further contributory evidence of the former existence of a land connection, probably by way of the Antarctic Continent, between these two countries.

Scutigerella caldaria Hansen. (Figs. 1–6.)

Scutigerella caldaria Hansen, Q.J.M.S., vol. 47, p. 36, pl. 2, figs. 3*a*–3*g*, 1904.

Head.—Seen from above broad, anterior margin straight, postero-lateral angles rounded

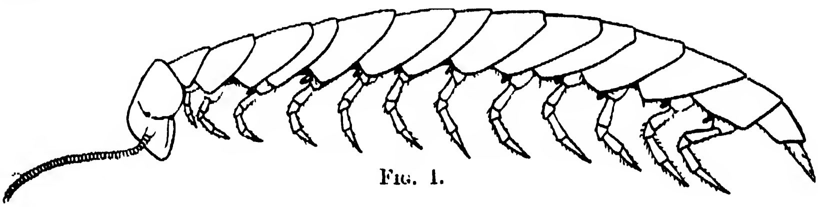


Fig. 1.

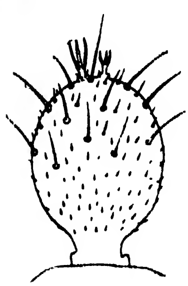


Fig. 2.

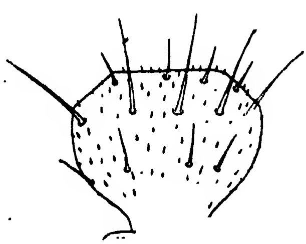


Fig. 3.

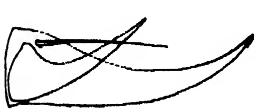


Fig. 4.

Fig. 1.—*Scutigerella caldaria* Hansen.
Fig. 2.—Terminal joint of antenna.
Fig. 3.—36th segment of antenna.
Fig. 4.—Claw of 1st leg, left side.

Antennae (figs. 2 and 3).—Segments 44 in number. The setae on the inner side of the proximal whorls not longer than those on the outer side. The secondary whorl beginning on the 11th joint, the upper whorl commencing on the 25th segment. The terminal segment with one large and one small striped organ, both on low protuberances. Hansen states that there are from 23 to 28 antennal segments, and that the secondary whorl commences on the 7th segment. The specimen I have described is much larger than those Hansen described—his were from 2·8 mm. to 4 mm., mine is 6·25 mm.—and, taking this into consideration, I do not think that the

number of the antennal segments alone would be a sufficient reason for making a new species. Further, the secondary whorl of setae commences at one-quarter of the length of the antennae in each case.

Legs.—The last pair (fig. 6) with tarsus five times longer than deep. The metatarsus with 5 or 6 and the tarsus with 7 spines on the outer dorsal row; the setae increase gradually a little in length from the base to the end of each joint, but the longest setae are shorter than half the depth of the meta-

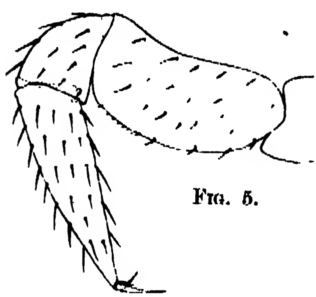


FIG. 5.

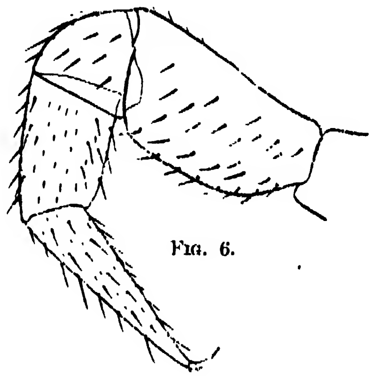


FIG. 6.

FIG. 5.—1st leg, left side: 88.
FIG. 6.—Last leg, left side: 75.

tarsus. The first pair of legs (fig. 5) with the anterior claw (fig. 4) elongate, moderately slender, and a little curved; the other claw moderately slender and a little more than half as long as the anterior one.

Cerci with numerous short setae, of which the distal ones are not half as long as the depth of the cerci.

Hab.—South America, New Zealand, and Europe (? introduced).

Locality of New Zealand specimen, Ben Lomond, Lake Wakatipu, Central Otago.

Length, 6·25 mm.

ART. XXXII.—*The Fresh-water Crayfish of New Zealand.*

By GILBERT ARCHEY, M.A., Assistant Curator, Canterbury Museum.

[*Read before the Canterbury Philosophical Institute, 2nd December, 1914.*]

Plate IV.

IN the following pages an account is given of the species and varieties of the New Zealand fresh-water crayfish, and of their distribution. This subject had previously been worked at, but had not been definitely settled, some doubt existing as to whether the crayfish found in Canterbury and Otago were to be considered as distinct species or only as varieties.

This paper contains, first, a summary of the work hitherto published on the subject; this is followed by a description of the crayfish found in the different parts of New Zealand, and an account of the distribution of the species and varieties. Some notes on the habits and mode of life of the crayfish are then given, diagnoses of the species, and a bibliography.

Both in collecting material and in the arrangement of this paper I was given much valuable assistance by Dr. Chilton, to whom I wish now to tender my sincere thanks. I have also to thank Dr. Benham, who offered many helpful suggestions.

Historical.

The genus *Paranephrops* was created in 1842 by Adam White, who described as the type species *Paranephrops planifrons*. "Dieffenbach's Travels," published during the following year, also contained a description of *P. planifrons* White, in which reference was made to supposed resemblances to *Nephrops*. White again, in 1847, described a specimen, collected by Mr. Percy Earl, under the name *Astacus zealandicus*. In this paper he made no reference to *Paranephrops planifrons*, which he had described five years previously. The species described as *A. zealandicus* is clearly that now known as *Paranephrops zealandicus*. This description of White's was republished in the following year in the "Annals and Magazine of Natural History."

In 1852 J. D. Dana described a crayfish obtained from the Bay of Islands, under the name *Paranephrops tenuicornis*. It had, on the squame of the antenna, an inner apex not far from the end, "mostly concealed by the fringe of plumose setae, which extends along the inner margin." This feature is figured in his Atlas; it will be referred to later in this paper. In his "Classification of the *Crustacea*" (1859) Dana includes *Paranephrops* under the *Nephropinae*, family *Astacidae*.

In 1873 Captain F. W. Hutton described a new species of *Paranephrops* which he named *P. setosus*. This species had a thorny-sided carapace, a slight median ridge on its upper surface, the hand bearing spines and numerous long hairs on its outer surface, and a broad flattened rostrum. The habitat given was "stream near Invercargill, Province of Otago; and River Avon, near Christchurch, Canterbury." The specimen from Invercargill would probably belong to the species now known as *P. zealandicus*.

Miers (1874), in the list of *Crustacea* of the "Erebus" and "Terror" expedition, mentions *P. planifrons* and *P. zealandicus*. He thought that *P. tenuicornis* Dana and *P. planifrons* White were identical, and that the form described by White (1847) under the name of *Astacus zealandicus* should be referred to *Paranephrops*.

J. Wood-Mason (1875), in a note on *Temnocephala*, an external parasite found on these fresh-water crayfish, remarked that he had received from Captain Hutton a series of specimens of the fresh-water crayfish lately described by him in the "Annals and Magazine of Natural History" under the name of *Paranephrops setosus*. He continues, "I have since received from my friend Mr. W. Guise Brittan, of Christchurch, an abundant supply of each of *two* species of crayfish from the *Rivers Avon and Waimakariri respectively*." The italics here are mine; the question as to there being distinct species in the Rivers Avon and Waimakariri will be discussed later. In 1876 Wood-Mason exhibited before the Royal Society of Bengal some specimens of New Zealand crayfish to which he gave the name *Astacoides tridentatus*, "from the presence of three spines on the inferior edge of the rostrum." These specimens are now in the Indian Museum.

In the same year he published a note on the "Mode of Attachment of the Young of *Astacoides zealandicus*," which species, he said, was the same as *Paranephrops setosus* Hutton; but Miers (1876) considered it to be *P. zealandicus*.

In 1876 E. J. Miers published a "Catalogue of the *Crustacea* of New Zealand," in which he recognizes the three species—*P. planifrons*, *P. zealandicus*, and *P. setosus*—quoting White's original description for *P. planifrons* (1842) and for *P. zealandicus* (1847), and that of Hutton for *P. setosus* (1873).

Dr. Chilton, in his first paper on the fresh-water crayfish (1883), definitely described the differences between the English crayfish (*Astacus fluviatilis*) and a New Zealand one (*Paranephrops setosus*). *P. planifrons* he recognized as a species quite distinct from the South Island form; but he agreed with Professor Hutton that *P. zealandicus*, which was described by White in 1847, and had not since then been recognized in New Zealand, was probably "nothing more than a young specimen of *P. setosus* Hutton."

In 1885 Filhol recorded the three species, *P. planifrons* White, *P. zealandicus* (White), and *P. setosus* Hutton.

In 1889 Dr. Chilton published a second paper on the subject, entitled "The Distribution and Varieties of the Fresh-water Crayfish of New Zealand." The investigation was undertaken with a view to settling the question raised in his first paper (1883) of the identity of the two species *P. setosus* Hutton and *P. zealandicus* (White). He remarked that the characters in which they differ varied to a large extent, owing to size and age, even in specimens taken from the same stream, and such a complete series of transitions was found that it would, he thought, be found necessary to combine the two species. The name then given to the South Island species was *P. neo-zelanicus*. *P. planifrons*, too, exhibited a wide range of variable characters, sometimes approaching the South Island form. An important point was the distribution of *P. planifrons*, commonly called the North Island species, but found also all over the north-western part of the South Island. Dr. Chilton's conclusion was: "It would hence appear that Cook Strait has not proved so great, or, rather, so old a barrier to these crayfish as the mountains in Nelson forming the northern continuation of the Southern Alps."

Walter Faxon (1898) gave a detailed description of the three species from material supplied by Dr. Chilton. He considered *P. tenuicornis* Dana to be the same as *P. planifrons* White. With regard to *P. zealandicus* (White) and *P. setosus* Hutton, which Dr. Chilton (1889) had combined under the name *P. neo-zelanicus*, he considered that "the two species are perfectly distinct, even young, very small specimens being easily distinguishable."

Dr. H. Lenz (1901) recorded the occurrence of "*P. setosus*" from D'Urville Island, but as the specimens I have received from this locality and from Nelson and Blenheim are all distinctly *P. planifrons* I have concluded that his identification is incorrect. There is nothing in the description given to indicate definitely to which species it belongs.

It will be seen from the foregoing that there has been some difference of opinion as to whether *P. zealandicus* and *P. setosus* are to be regarded as distinct species or not. In the latter part of the following description of the species this subject will be discussed.

General Account of the Species of Paranephrops and their Distribution.

The method adopted of working out the variations with a view to determining the distribution of the different species or varieties was that of comparative measurement for proportion. A series of measurements

was made, and certain proportions calculated for each specimen: and, in addition, the details of the spinulation or of the shape of different parts were recorded. From the tables thus compiled could be obtained more definite evidence of the existence of different local varieties than by mere observation.

In arranging the spines on the carapace into groups I have followed the system given by Dr. Chilton (1889, p. 243), and the "group letters" used here refer to the same sets of spines as they do in Dr. Chilton's paper. I have added group K, consisting of 3 or 4 small spines situated above the branchio-cardiac groove, and group L, found only in *P. setosus* and *P. zealandicus*, placed on the posterior portion of the gastric area, level with group B.

A. General Description of Paranephrops planifrons. (See Plate IV, fig. 1, and text fig. 1; also measurements, Table 1, p. 313.)

I. *Carapace, Length ÷ Breadth* (column 2).

There is a slight indication here that the crayfish grow a little stouter, comparatively, as they increase in size; but the difference is very much

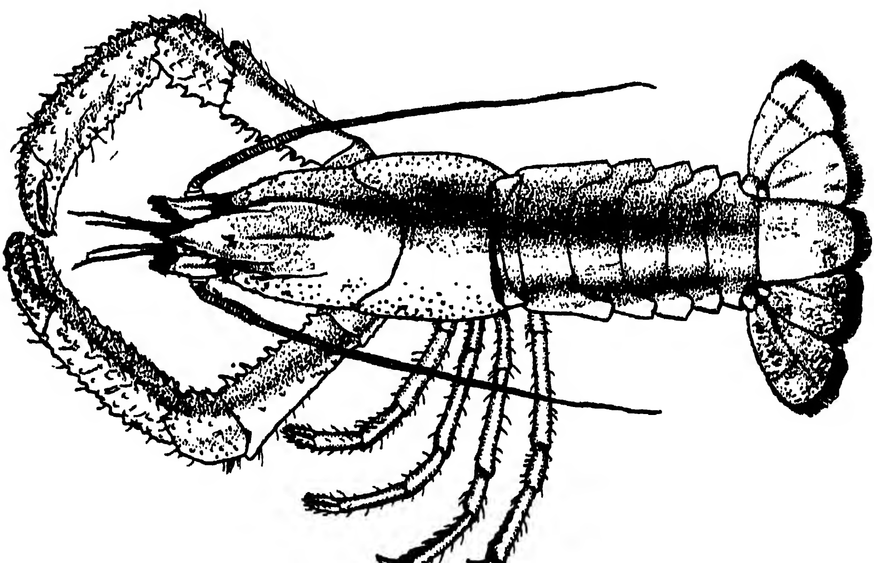


Fig. 1.—*P. planifrons* White. Specimen from Ross, Westland.

less than in *P. setosus*. There are no local variations with regard to this proportion.

II. *Bulging of the Sides of the Cacapace.*

The sides of the carapace are, in moderate-sized individuals, practically straight, or, at most, with only a slight bulge; in the larger specimens, however, from Wanganui, New Plymouth, and Napier, there is a distinctly oval carapace, further emphasizing the fact that the animals grow comparatively stouter as they increase in length.

III. *Nature and Arrangement of the Spines on the Carapace* (fig. 2).

A. Two sharp spines always present.
B. Average number 5, present in specimens 60 mm. or more in length.
C. Increase in number according to the size of the specimen, up to 5 or 6.
D. Vary in number with the size of the specimen; they are sometimes situated on a slight ridge on the carapace.
E. One or 2 (very rarely 3), on a distinct ridge.
F. Present only in large crayfish; usually 3 in number.
G. These spines vary in number from 0 to 6, in accordance with the size of the specimens. Specimens about 80 mm. long have either 3 or 4.

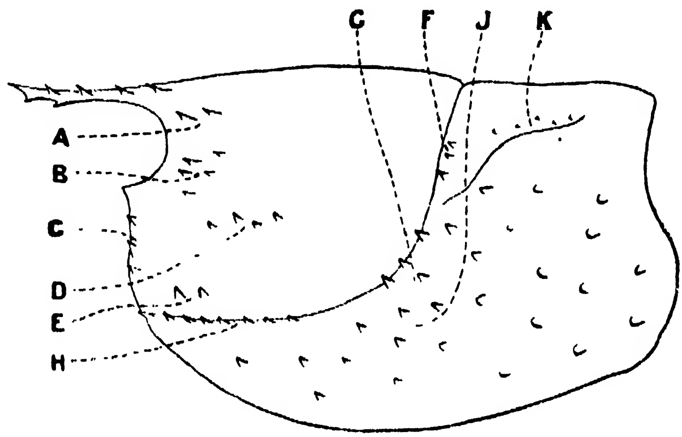


FIG. 2.—Carapace of *P. planifrons*, showing arrangement of spines.

H. This group varies in number from 4 to 13, independently of size, sex, or locality; 7 and 9 are most commonly found.
J. The anterior portion of this region is armed with spines, merging into small rounded tubercles posteriorly.
K. Present in the larger specimens only; usually 3 or 4 in number, but 11 have been found here.

IV. *Total Body Length ÷ Rostrum Length* (column 4).

The usual specific proportion is 6·5. The Hawke's Bay and Napier specimens have a slightly longer rostrum (average proportion, 5·96), and the Wellington and north-east Marlborough specimens have a very short rostrum (proportion, 7·1)—shorter, indeed, than in *P. setosus*.

V. *Rostrum Length ÷ Rostrum Breadth* (column 3).

There is not much definite variation correlated with definite localities, but the rostrum of crayfish from south of Wellington (inclusive) is considerably wider than that of those in the north. There are individual exceptions to this rule—*e.g.*, D'Urville Island and Spring Creek specimens have a narrow rostrum, while the Rotorua specimens have a wide one; but generally the proportion is the same.

VI. *Carina on Rostrum.*

There is a median keel extending forward from the cervical groove as far as the anterior of the post-orbital spines (group A) in all specimens of *P. planifrons*. This keel is continued anteriorly to about half-way along the rostrum in specimens from Richmond, Murchison, and Pelorus.

VII. *Spines on Rostrum* (column 5).

The most usual number of spines on the rostrum is 4 on each side, with 1 or 2 below (occasionally 0 or 4). Specimens from the Eastern Cook Strait district have often 5 spines on each side, and this shows an approach to *P. zealandicus*. The northern specimens (Puriri and Manukau) have only 3 on each side.

VIII. *Rostrum Length in Proportion to the Length of the Peduncle of the Antenna.*

The rostrum terminates level with or slightly beyond the peduncle of the antenna in all but the Western South Island group, where it reaches only to half-way along the last segment of the peduncle.

IX. *Antennal Scale.*

(*a.*) *Length in Proportion to the Total Body Length* (column 6). -The length of the antennal scale varies in accordance with the locality. It is shortest in the Eastern Cook Strait group (8·4 average proportion), longer in the Western South Island group (7·8), considerably longer in the ordinary North Island group (6·6), and exceptionally long in the Manukau specimens. The proportionate length of the squame in the Eastern Cook Strait group is less than in *P. setosus*.

(*b.*) *Squame ÷ Peduncle* (column 7). —The figures here show that the squame is shorter than the peduncle in the Western South Island and the Eastern Cook Strait groups, while in the ordinary North Island forms the squame is slightly longer.

(*c.*) *Shape* (fig. 3).—The squame is normally long and narrow, tapering from the posterior third. The variations found are that the Ross specimens were slightly broader (they were very large crayfish); those from Murchison were very distinctly short and broad, two small specimens having an almost semicircular squame. With the exception of the Spring Creek forms, the Eastern Cook Strait group showed a slightly broader squame, in which the broad appearance was somewhat accentuated by the tapering not commencing till nearly half-way along its length. The Manukau and Puriri crayfish had exceptionally long antennal scales.

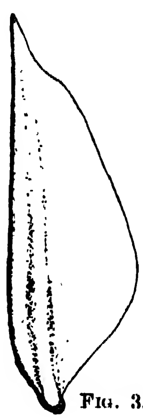


FIG. 3.

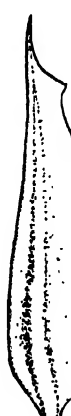


FIG. 4.

FIG. 3.—Antennal scale of *P. planifrons*; × 3.

FIG. 4.—Antennal scale of *P. tenuicornis* Dana (after Dana).

The opportunity is taken here to refer to Dana's (1855) drawing and description of the squame of *P. tenuicornis* (= *P. planifrons*), said to have

a tooth placed anteriorly on the inner edge. In all the crayfish I have examined I have never seen this tooth as pictured by Dana. There is, however, in some of the specimens a rather sharp turn in the sweep of the edge of the squame, which, if exaggerated, might suggest a spine or tooth. The specimen examined by Dana was obtained from Bay of Islands. I have not seen any crayfish from this locality (the most northern forms I have examined are from Manukau Harbour), and therefore cannot say whether a variety with this character actually exists, or whether the artist has exaggerated the "corner" on the inner edge of the squame.

X. *Length of Carapace in Proportion to the Length of the Body.*

The measurement was taken from the tip of the rostrum to the middle of the posterior edge of the carapace. The only indication of locality groups with regard to this character is that the Rotoiti and Thames specimens have a somewhat shorter carapace; but in each locality where male and female specimens were obtained the female has a shorter carapace than the male.

XI. *Chelae; Propod Length ÷ Propod Breadth.*

The average proportion for ♂ is 3·36, that for ♀ is 3·16, indicating that the propod of the female is slightly broader than that of the male.

XII. *Spinulation of the Chelae* (fig. 5, *a* and *b*).

There is usually a single spine on the lower surface of the basis, though there may be 2 or 3 in large individuals. In small specimens the upper surface of the ischium is smooth, but in moderate-sized individuals it becomes toothed with from 3 to 5 edentations. From its lower surface 2 sharp spines project, with from 1 to 6 smaller spines or tubercles lying between them.

On the upper edge of the merus there are 2 rows of irregularly placed spines, the outer row consisting of 2 or 3 small tubercles posteriorly, and 3 or 4 spines anteriorly. The lower surface has 2 rows of either 5, 6, or 7 spines. A sharp spine is present on each side of the anterior end of this joint, and sometimes there is a complete ring of about 7 spines here. This ring is particularly noticeable in Napier, Hawke's Bay, Wanganui, and New Plymouth specimens, and in some Ross and Nelson specimens.

FIG. 5.—Chela of *P. planifrons*: *a*, from above; *b*, from below.

The inner margin of the carpus has 3 or 4 large sharp spines; its upper surface is provided with 2 irregular rows of blunt spines; on some small specimens 5 or 6 blunt spines are found on the outer surface of the carpus; in larger specimens these spines are sharp; there are usually 4 spines on the lower surface.

The inner margin of the propod is armed with 2 rows of large sharp spines, which are continued on to the corresponding margin of the dactyl. The upper surface of the propod has 2 median parallel rows of spines, and smaller irregularly arranged tubercles on the outer region; the outer margin has 2 parallel rows of short close-set spines. The spinulation of the lower surface is very similar to that of the upper surface, except that there is a tendency for the outer small tubercles to run in either 2 or 3 irregular rows.

There is always a large spine situated centrally on the posterior margin of the dactyl, and also one in a corresponding position on the lower surface.

Both the carapace and chelae are singularly free from hairs; when present, they occur on the anterior side of the base of the tubercles, and are not observed at a casual glance.

Distribution of P. planifrons.

P. planifrons can be divided into four rather ill-distinguished groups, the tendency throughout being towards more slender crayfish as we go farther north.

The first group, which may be regarded as the normal, extends over the central part of the North Island—the district bounded by Masterton, Wanganui, New Plymouth, Whangarata, Rotorua, and Napier. The foregoing description will, in general, apply to this group.

The second, or Northern group, found north of Whangarata, is characterized by a greater slenderness of form, both in the body and in the chelae.

The East Cook Strait group, which includes specimens from Wellington (city), Marlborough, and Pelorus Valley, is marked by an approach in the proportion of certain parts to *P. setosus*—that is, the crayfish have a short, broad rostrum with 5 spines on either side, and a shorter and broader squame. It is to be noted, however, that the Spring Creek and D'Urville Island specimens have the characteristic long narrow squame and rostrum of the normal North Island form.

The last group, the Western South Island group, differs only slightly from the normal group, having a slightly shorter squame, tapering from half-way, and a shorter, though not comparatively broader, rostrum. In some specimens of this group there is a median rostral carina.*

Although the last two groups show an approach in certain proportions to *P. setosus*, there is no doubt whatever that they are *P. planifrons*, the arrangement of the spines on the carapace and chelae, and the shape of the carapace and chelae, being distinctly that typical of *P. planifrons*.

* When this was written I had examined specimens of *P. planifrons* only from as far south as Ross, but had heard that crayfish, presumably *P. planifrons*, were to be found in the Wanganui River, about twenty-five miles farther south. Recently, however, I received a specimen, unmistakably *P. planifrons*, from Cromarty, near Preservation Inlet. So we now have *P. planifrons* extending all along the west coast of the South Island, evidently separated from *P. zealandicus* by the main watershed of the Island. At Clifden, to the east, distant fifty miles direct from Cromarty, the crayfish are the most perfectly definite forms of *P. zealandicus*.

The following table shows the average proportions of the parts measured in each of the above groups. Only those proportions which show differences between the groups are given.

	Body Length ÷ Squame Length.	Body Length ÷ Rostrum Length.	Rostrum Length ÷ Rostrum Breadth.	Rostrum Spines.
Normal group ..	6·6	6·23	2·30	$\frac{4-4}{1·5}$
Northern group ..	6·0	5·60	2·40	$\frac{3-3}{1}$
East Cook Strait group	8·4	6·50	1·82	$\frac{5-5}{1}$
West South Island group	7·8	7·10	2·08	$\frac{4-4}{1}$

B. GENERAL DESCRIPTION OF PARANEPHROPS SETOSUS. (See Plate IV, fig. 2, and text fig. 6; also measurements, Table 2, p. 314.)

Paranephrops setosus is found in the rivers of Canterbury as far south as Winchester. Specimens were examined from Omihi, Rangiora, Waimakariri River, Styx River, Avon River, Heathcote River, Leeston, Peel Forest, and Winchester.

I. *Carapace.*

P. setosus is distinguished by a distinctly oval carapace, narrowing towards the anterior end. Specimens from Winchester and Peel Forest,

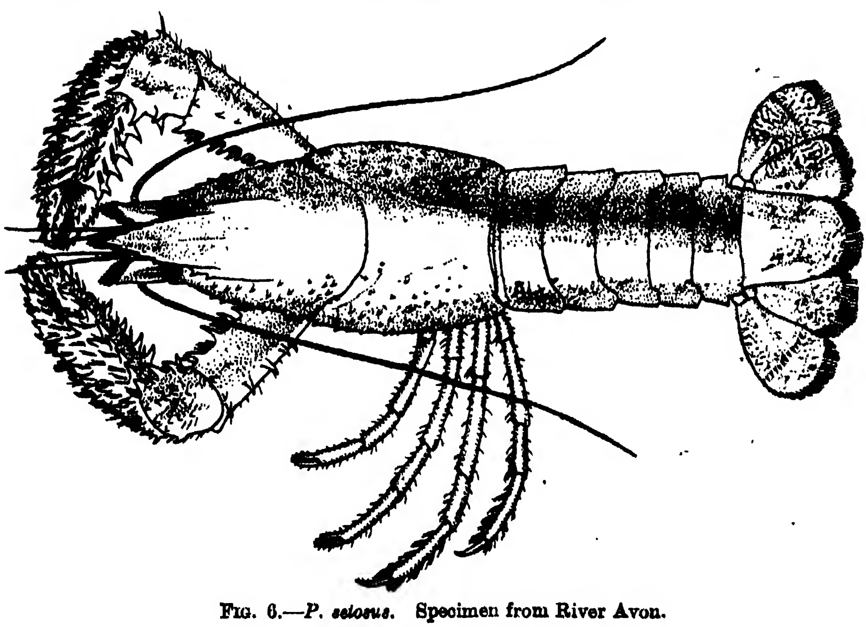


FIG. 6.—*P. setosus.* Specimen from River Avon.

however, have a less oval carapace. By comparing column 1 with column 2 in Table 2 it will be seen that the animals become comparatively stouter as they increase in length.

II. *Nature of the Spines of the Carapace.*

The carapace of *P. setosus* is covered with sharp, forwardly directed spines, which can be arranged in the same reference groups as in *P. planifrons*. The arrangement of the spines is exactly the same in *P. zealandicus* as in *P. setosus*, but in *P. zealandicus* rounded tubercles take the place of the sharp spines. The following account of the arrangement of the spines will be equally applicable to the two species.

III. *Arrangement of the Spines on the Carapace,* P. setosus *and* P. zealandicus.

A. Constantly 2 in number.
B. Increasing in number according to the size of the specimen. In moderate-sized individuals the number is from 6 to 8.
C. Usually 4 or 5, appearing first in specimens of 50 mm. length.

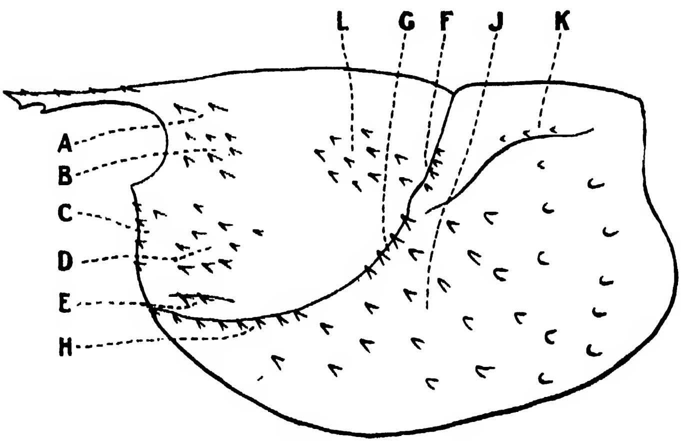


Fig. 7.—Carapace of *P. setosus*, showing arrangement of spines.

D. There are generally from 10 to 12 spines here; they are first developed in specimens 50 mm. long.
E. A ridge on the carapace in this region bears 1 or 2 spines; occasionally a third is developed.
F. Five or 6 is the greatest number found here; they appear only in the large specimens.
G. This group is constant in specimens of 50 mm. or more in length. The spines, which are very distinct, are usually 3 or 4 in number.
H. Five or 6 spines appear here in specimens 40 mm. long; the usual number in ordinary-sized individuals is 8.
J. These are quite distinct and fairly numerous just behind the cervical groove, but become fewer and less distinct posteriorly.
K. These spines are not often present, and do not appear in specimens under 90 mm. long. When present, there are only 4 or 5 developed.
L. This is a large group, varying considerably in number. The usual number for moderate-sized specimens is 10–12.

IV. *Rostrum* (columns 3, 4, and 5).

The rostrum is shorter in proportion to the body length than in *P. planifrons*, and it is also shorter in proportion to its own width. Specimens from Rangiora and Peel Forest have a rostrum still shorter than is usual for the species. There is also a distinct median keel on the anterior portion of the upper surface of the rostrum: it is not so distinct in the Peel Forest specimens. There are usually 4 sharp distinct spines on each side of the rostrum, and 1 or 2 below.

V. *Antennal Scale* (columns 6 and 7; fig. 8).

The antennal scale is fairly long and narrow, though not so long as in *P. planifrons*; it is nearly as long as the peduncle of the antenna; it tapers from the posterior third.

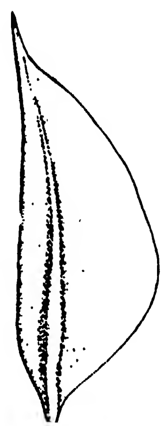


FIG. 8.—Antennal scale of *P. setosus*; ×3.

VI. *Chelae* (fig. 9).

The upper surface of the ischium is slightly serrated in moderate-sized individuals, but large specimens have distinct, forwardly directed teeth; on the lower surface are 2 sharp spines, with 1 or 2 small tubercles between them in large specimens.

On the posterior portion of the upper margin of the merus is a single row of spines leading forward on the anterior part to 2 rows; there are 2 irregular rows on the lower margin, and on each side of the anterior margin is a single forwardly directed spine.

The inner surface of the carpus has usually 3 large spines; the upper surface has 2 irregular rows of small spines, separated by a shallow groove; there are small tubercles on the outer surface, and 3 or 4 large sharp spines on the lower surface.

On the inner margin of the propod there is a row of sharp spines, continued, with smaller spines, along the corresponding edge of the dactyl. Above this row there is, on the dactyl, another row of smaller spines, commencing usually with 1 spine on the anterior portion of the propod. The outer edge of the propod has 2 rows of close-set, short spines. On the pos-

terior part of the upper surface there are long spines arranged irregularly; these merge anteriorly into 2 rows. Two median rows are present on the lower surface of the propod.

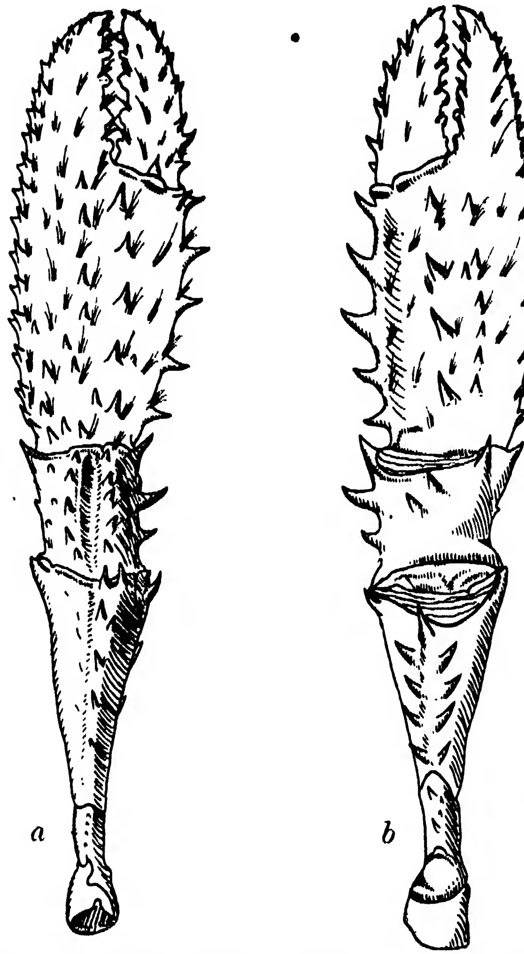


Fig. 9.—Chela of *P. setosus*: *a*, from above; *b*, from below.

There are abundant tufts of hair on the propod, but they do not hide the spines.

C. General Description of Paranephrops zealandicus. (See Plate IV, fig. 3, and text fig. 10; also measurements, Table 3, p. 314.)

Specimens of *P. zealandicus* were obtained from Tinwald, Waimate, Glenavy, Oamaru, Waitati, Dunedin, Wyndham, Clifden, and Stewart Island.

The carapace is nearly cylindrical in shape, and does not bulge, as in *P. setosus*. This does not mean that *P. zealandicus* is more slender than

P. setosus, for the shape of the latter is due to the narrowing of the anterior part of the carapace. In fact, the measurements indicate that *P. zea-*

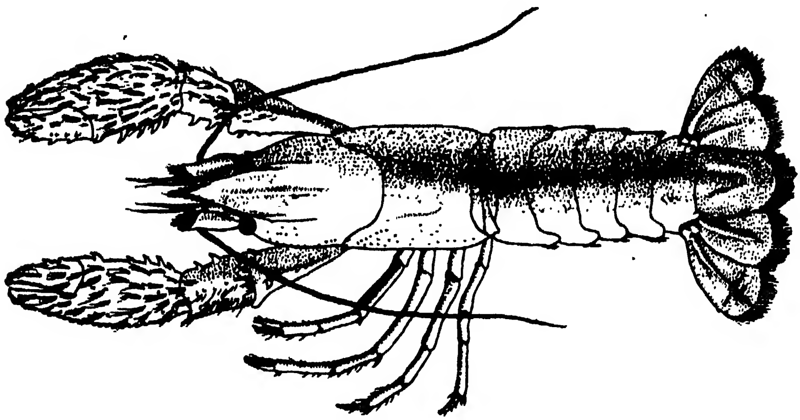


FIG. 10.—*P. zealandicus* (White). Specimen from Waimate.

landicus has a very slightly wider carapace than *P. setosus*. As mentioned above, rounded tubercles replace the spines on the sides of the carapace of *P. setosus*.

The rostrum (columns 3, 4, and 5) is considerably shorter and broader in *P. zealandicus* than in *P. setosus;* there is no median keel on its anterior portion, and there are 5 blunt tubercles on either side, and none or 1 on the under-surface.

The antennal scale (columns 6 and 7; fig. 11) also is shorter and broader in *P. zealandicus* than in *P. setosus;* the broad appearance is enhanced by the fact that it tapers abruptly from half-way.

Chelae.—The spinulation of the chelae differs in certain points from that in *P. setosus*. On the upper surface of the carpus small rounded tubercles are found instead of spines; the upper surface of the propod is provided with a few tubercles, completely hidden by dense tufts of hair; these tubercles are arranged irregularly posteriorly, merging to one median row anteriorly. In other respects the arrangement of the tubercles is similar to that of the spines on the chelae of *P. setosus* (*cf.* fig. 9).

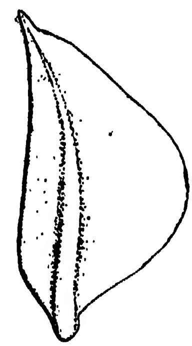


FIG. 11.—Antennal scale of *P. zealandicus*; × 3.

DISTRIBUTION OF P. SETOSUS AND P. ZEALANDICUS.

P. setosus is found only on the eastern side of the South Island, from Omihi in the north to Winchester in the south. I have not obtained them from among the mountains, but only from the lower parts near the coast, and then not from the rapid shingle-bed rivers themselves, but from creeks or pools leading into them. The results of observations by tourist parties and the mountain guides, to whom application was made, as to their occurrence high above the sea-level or in the cold rapid mountain torrents are entirely negative. It is to be noted that, although the Winchester speci-

mens are distinctly *P. setosus*, north of this—at Peel Forest and Tinwald—are found crayfish which it is difficult to place definitely in either species. They have some of the characters of *P. setosus* and some of *P. zealandicus*. They have been assigned to the species of which they have the most characters. The Peel Forest specimens are, therefore, named *P. setosus*, and the Tinwald specimens *P. zealandicus*. South of Winchester the crayfish found are all distinctly *P. zealandicus*, which extends right to the south of the Island and to Stewart Island, and has been traced in the south-west as far as Clifden. Here, also, there is no definite record of their occurring far up the rivers, although a gentleman writing from Gore, in Central Otago, states that they used to be common in the district, and a correspondent from Lawrence reports that they are found there.

In the historical portion of this paper mention was made of the occurrence recorded by J. Wood-Mason (1875) of "two species of crayfish from the rivers Avon and Waimakariri respectively." Through the kindness of Mr. S. Kemp, of the Indian Museum, Calcutta, the specimens which formed the subject of Wood-Mason's paper were obtained for examination. They were entered in the Indian Museum Register as follows:-

"900. *Astacoides setosus*, Hutton. R. Waimakariri, N.Z., a few miles within influence of tide. W. Guyse Brittan."

"901. *Astacoides tridentatus*, Wood-Mason. Types. R. Avon, N.Z. Several miles above tidal influence. W. Guyse Brittan."

Of these, No. 901 belong to *Paranephrops setosus* Hutton, of which *Astacoides tridentatus* Wood-Mason is a synonym, and no doubt really came from the River Avon. But No. 900 really belong to *P. zealandicus* White, and probably came not from the River Waimakariri, but from the Bluff, the locality label having been interchanged with other specimens, "No. 890/7," which are labelled as coming from "The Bluff, S. Is. N. Zealand, A. V. Hugel"; these, however, are undoubtedly specimens of *P. setosus* Hutton, and doubtless came from the Waimakariri.

Bionomics.

(A.) *Mode of Life.*

It has been seen that crayfish are to be found in most parts of New Zealand, but their number and size vary in the different districts, seemingly in accordance with the type of stream or pool in which they are found. Soft, muddy river-beds seem to be their favourite homes, while they are often found in holes in a sunken log or burrowing among the roots of trees growing on the river-banks. An example of their restriction to this type of locality is seen in their occurrence in the Waimakariri River. This stream divides into two branches about twenty miles above its mouth; of these, the south branch is the typical rapid shingle-bed river, while the north branch flows comparatively slowly between soft banks. Crayfish have been obtained from the north branch, but I have never heard of their having been found in the south branch.

Two other localities where they are said to occur in great numbers, and to grow to a large size, are the plains of Southland and the holes and pools in the basins lying among the hills of South Canterbury. They are also plentiful in the streams draining the low-lying somewhat swampy land around Christchurch. In parts of Southland the water-races are said to be "simply swarming with crayfish," which sometimes do an immense amount of damage by burrowing into the banks.

Since this paper was read before the Canterbury Philosophical Institute Mr. A. Dudley Dobson has informed me that some years ago, when water-races were first constructed from the Murray River in Australia, the crayfish did so much damage to them that the races had to be lined with concrete.

Amongst the hills around Waimate are many deep pools, known as the "Crayfish Holes," from which the crayfish can be taken in any quantity. Faxon (1898, p. 681), quoting from a letter received from Dr. Chilton with regard to specimens obtained near Dunedin, observed that the specimens taken from small streams were of very small size, though sexually mature, and had few spines, while those taken from a reservoir formed by damming up one of the small streams attained a length of 158 mm. and were heavily tuberculated. This is also the case with the specimens I have used, and it seems that fairly deep, slow-moving waters provide the best conditions for their growth.

A similar example of the connection between the size of an animal and the volume of water in which it lives appears in Semper's volume on "Animal Life" (1899, pp. 160-61) in the International Scientific Series, which contains an account of two series of experiments connected with the growth of a gastropod mollusc—*Limnaea stagnalis*—living in different volumes of water, but otherwise in equally favourable conditions for growth. The results were that "the smaller the volume of water which fell to the share of each animal, the shorter its shell remained."

The abundance of crayfish in special localities suggests that it would be possible to breed the animals for use as articles of food, for they are said to be excellent eating; but it would be necessary, before this could be done successfully, to ascertain the number of years they require to grow to a full size, as well as to obtain more definite information with regard to their breeding and life-history. The frequent floods to which so many of our rivers are subject are the cause of the destruction of large numbers of crayfish, which may be washed out of the small streams into the deep rapid rivers. A correspondent from Southland has stated that he has seen hundreds washed up on the lower beaches of the large rivers after a flood. It is also evident that, in common with other members of our native fresh-water fauna, the crayfish are being destroyed by eels and the introduced fishes. Trout have been caught with partly digested crayfish in their stomachs, and it is probable that the restriction of crayfish to such places as cannot be inhabited by these fish is only a matter of time.

(B.) *Food.*

Some specimens were kept for a time in large glass battery-jars, into which was thrown a certain amount of river-weed, mainly for the aëration of the water. The crayfish were never actually seen eating any of this, but at evening it was noted that the bottom of the jar was quite clean, while in the morning there would be seen lying around chopped-up pieces of the plant. Small worms or pieces of meat placed in the jar were invariably left untouched, though crayfish are often caught by using meat as bait. An examination of the contents of the stomach of several individuals showed the presence of the roots and stems of plants, pieces of such fresh-water algae as *Spirogyra* and *Vaucheria*, together with broken fragments of the different kinds of small animals generally found amongst the river-weed. A fairly large piece of the flesh of some animal was found in the stomach of one individual.

(C.) *Colour.*

The colour is usually a mottling of green and grey, which harmonizes well with the beds of streams; some, however, are of a yellowish or a light-brown colour. Those taken from the ponds of the New Plymouth Public Gardens are almost black in colour, and this is no doubt correlated with the colour of the mud on the bottom of the ponds, which Mr. W. W. Smith, the curator, tells me is quite black. Some specimens from the Wanganui River were also very dark.

It is an interesting fact that now and then a crayfish is met with that is of a bright-red colour, similar to that of a boiled lobster.

Dr. Marion Newbigin (1898, pp. 117, 129), in her book "Colour in Nature," divides the colours of *Crustacea* into two series, the first series containing the red lipochromes and a yellow pigment, while the second series contains soluble blue pigments. She further shows that there is reason to believe that "when mixed with the yellow pigment, or with the red lipochrome, this blue pigment gives rise respectively to green and brown colours" (p. 129).

A possible explanation, then, of the occurrence of red crayfish might be that the pigment representing the soluble blue series is absent in these forms. That the blue pigment is the less stable is seen in its disappearance when crayfish are boiled or placed in alcohol. In connection with this, Dr. Newbigin states that in the living animal "the blue or cyanic series occur . . . in solution, while the reds occur in fixed anatomical elements—the chromatophores."

(D.) *Eggs.*

The fresh-water crayfish become sexually mature a considerable time before they attain to their full size. Several ovigerous females were obtained which were only 52·5 mm. in length; but these were from the Khandallah Stream, Wellington, from which no specimens greater than 77 mm. were taken. Many of the ovigerous females, however, taken from other districts were not equal in size to the largest specimens from their district. As is to be expected, the number of eggs carried increases in proportion to the size of the crayfish. The accompanying table shows the number of eggs carried on some different-sized females:—

Length of Animal. Mm.	Number of Eggs.
52·5	23
57·0	26
66·0	56
71·0	60
76·0	72
90·0	120
96·0	160

(E.) *Difference noted between Males, Ordinary Females, and Ovigerous Females.*

With regard to the relative width of the abdomen in males and females, I found that when trying to pick out the males from the females by looking at them from above I was as often wrong as right. Ovigerous females, however, could usually be detected. Below are given the average propor-

tion (" total length ÷ breadth of abdomen ") for five ovigerous females, six females without eggs, and ten males, all collected around Wellington :—

Males	4·95
Females without eggs	5·03
Ovigerous females	4·58

It can be seen, then, that the females usually have an abdomen no broader than that of the males, but that when they are bearing eggs their abdomen is slightly broader. This is due not to any actual increase in size of the abdomen, but to its being slightly flattened, the pleura projecting outwards to a slight extent.

(F.) *Relative Abundance of Males and Females.*

The males and females seem to be present in fairly equal numbers. Of those I have examined, fifty-eight are males and forty-three females; but large collections from the different localities will be necessary before any significance can be attached to these numbers. In comparing the relative sizes of the males and females it was noticed that in specimens from the different localities the male was more frequently the larger. It is to be noted, further, that the largest specimens obtained were three males from Dunedin. Further information, however, is required on this point also.

DIAGNOSES OF THE SPECIES OF PARANEPHROPS.

Genus **Paranephrops** White.

Paranephrops White, Gray's Zoolog. Miscell., No. 2, p. 79, 1842. Type : *Paranephrops planifrons* White.

Paranephrops planifrons White.

Paranephrops planifrons White, Gray's Zoolog. Miscell., No. 2, p. 79, 1842. *P. tenuicornis* Dana, Crust., Classif. and Geograp. Distrib., p. 1433, 1853. *P. planifrons* Filhol, Institut de France, iii, 2nd part, No. 1, p. 429, 1885 ; Chilton, Trans. N.Z. Inst., vol. 21, pp. 242–49, pl. x, figs. 1–3, 1889 ; Faxon, Proc. U.S. Nat. Mus., vol. 20, p. 678, 1898 (with references); Chilton, Trans. N.Z. Inst., vol. 32, p. 14, 1900. *P. setosus* Lenz, Zool. Jahrb., vol. 14, p. 441, 1901.

Carapace nearly cylindrical, of the same width throughout whole length of the branchiostegites, smooth, or with small tubercles or spines on the sides. Rostrum elongate, triangular, somewhat depressed, margins raised and usually with 4 teeth on each side, under-surface keeled and usually with 2 teeth. Basal scale of antenna long and narrow, tapering from posterior third, with further abrupt narrowing near the end, reaching as far as or beyond extremities of rostrum and penduncle of antenna. Median keel on the carapace extending from the cervical groove to the level of the anterior of the post-orbital spines. Chelae long and narrow, propod more than three times as long as broad, whole appendage densely spined, with spines arranged in rows on the propod, inner margin of propod armed with 2 rows of spines, hairs few or absent. Pleura of abdominal segments rather pointed at the infero-posterior angle, anterior edge longer and more convex than the posterior, and fringed with setae, posterior edge sinuous and scarcely curving forward.

Size.—From 49 mm. to 125 mm.

Hab.—Streams in North Island, and northern and western part of South Island, D'Urville, and Kapiti Islands.

Paranephrops zealandicus (White).

Astacus zealandicus White, Proc. Zool. Soc., London, pt. 15, p. 123, 1847. *Paranephrops zealandicus* Filhol, Institut de France, iii, 2nd part, No. 1, p. 429, 1885. *P. neo-zelanicus* Chilton (in part), Trans. N.Z. Inst., vol. 21, p. 249, 1889. *P. zealandicus* Faxon, Proc. U.S. Nat. Mus., vol. 20, p. 680, 1898 (with references); Chilton, Trans. N.Z. Inst., vol. 32, p. 15, 1900.

Cephalothorax cylindrical; carapace nearly smooth in small specimens, but in larger forms with rounded tubercles on the branchiostegite, along the cervical groove, and on the gastric area; a median carina runs over the gastric area, ceasing abreast of the anterior of the post-orbital spines; rostrum one-eighth as long as the body, and more than half as broad as long, slightly depressed, the edge thickened, with usually 5 small denticulations on each side; under-surface either unarmed or with 2 small spines. No median keel on the upper surface of the rostrum. Basal scale of antenna short and broad, tapering from half-way and projecting not quite as far as the peduncle. Chelae shorter and broader than in *P. planifrons;* propod two and a half times as long as broad, hand provided with spines on outer and inner margins, with rounded tubercles on the upper and lower surfaces, hidden by dense tufts of fine silky hair, arranged in longitudinal rows; inner margin of propod has only one row of spines.

Size.—54 mm. to 130 mm.

Hab.—Streams in South Canterbury, Otago, and Stewart Island.

Paranephrops setosus Hutton.

Paranephrops setosus Hutton, Ann. Mag. Nat. Hist., 4th ser., xii, p. 402, 1873. *Astacoides tridentatus* Wood-Mason, Proc. Asiatic Soc. Bengal, 1876, p. 4. *A. zealandicus* Wood-Mason, Ann. Mag. Nat. Hist., 4th ser., xviii, p. 306, 1876; Filhol, Institut de France, iii, 2nd part, No. 1, p. 429, 1885. *Paranephrops neo-zelanicus* Chilton (in part), Trans. N.Z. Inst., vol. 21, pp. 246–49, pl. x, figs. 1*a*, 2*a*, 1889. *P. setosus* Faxon, Proc. U.S. Nat. Mus., vol. 20, p. 681, 1898 (with references); Chilton, Trans. N.Z. Inst., vol. 32, p. 16, 1900.

Carapace oval, bulging behind the cervical groove, armed with distinct, forwardly directed, sharp spines along the cervical groove, and on the branchiostegite and gastric area. A median carina runs over the gastric area, and is continued less distinctly over the rostrum. Rostrum one-sixth of the total length of the body and twice as long as broad, depressed, edges raised and armed with usually 4 sharp, forwardly directed spines on each side, lower surface with a downwardly projecting median keel, armed with 1 or 2 spines. Basal scale of antenna longer than in *P. zealandicus*, tapering from the posterior third, projecting as far as or beyond peduncle. Chelae of the same proportions as in *P. zealandicus,* but with hairs less dense, and armed with prominent spines projecting above the hairs, but otherwise with the same arrangement as *P. zealandicus.*

Size.—35 mm. to 103 mm.

Hab.—Streams in North and Central Canterbury.

TABLE 1.—Average Measurements of Specimens of *Paranephrops planifrons* from each Locality.

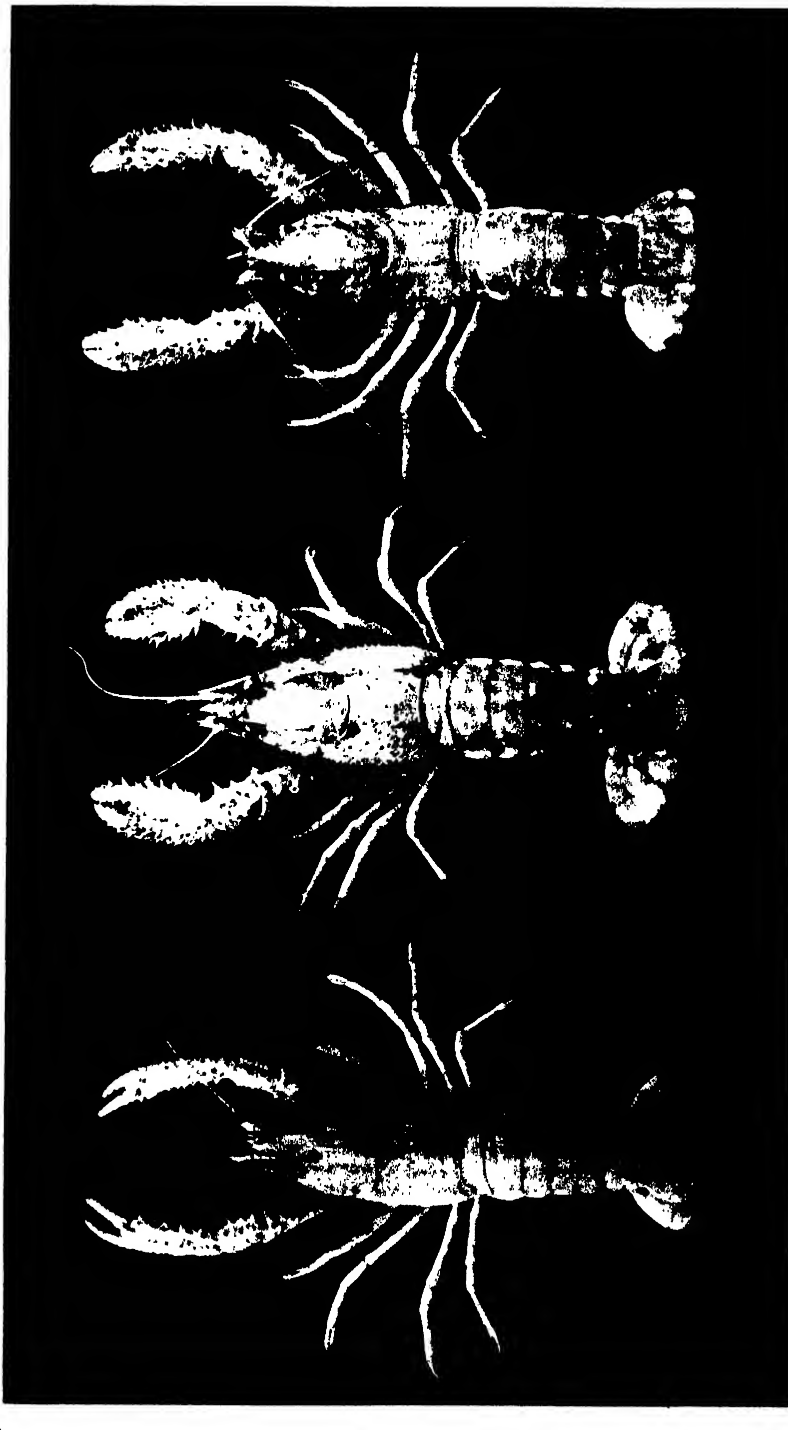
Column No.	1.	2.	3.	4.	5.	Antennal Scale.	
Specimen.	Average Length.	Carapace Length ÷ Breadth.	Rostrum Length ÷ Breadth.	Rostrum Length in Body Length.	Rostrum Spines.	6. Length in Body Length.	7. Squame ÷ Peduncle.
	Mm.						
Ross	125	1·90	1·80	7·70	$\frac{4-4}{0}$	8·8	0·85
Greymouth	90	2·19	2·29	6·08	$\frac{4-4}{2}$	7·5	0·98
Murchison	50·4	2·44	1·74	6·90	$\frac{4·5-4·5}{0}$	9·7	0·73
Aorere River	64	2·19	2·08	6·60	$\frac{4·5-4·5}{1}$	7·3	0·98
Wakefield	62	1·94	2·15	6·60	$\frac{4-4}{1·5}$	7·1	0·89
Brightwater	71	2·11	2·35	6·10	$\frac{4-4}{1·5}$	7·0	0·91
Richmond	99	2·24	2·12	6·80	$\frac{4-4}{1}$	7·7	1·30
D'Urville Island	62	2·08	2·70	6·01	$\frac{5-4·5}{2·6}$	5·4	1·30
Pelorus River	65·5	2·48	1·79	7·50	$\frac{5-5}{0}$	9·3	0·80
Kenepuru	49·5	2·26	1·66	8·30	$\frac{5-3}{0}$	9·7	0·77
Spring Creek	89	2·21	2·80	8·50	$\frac{4-4}{2}$	6·5	1·08
Ocean Bay	83·7	2·11	2·10	7·30	$\frac{4·5-4·5}{3}$	8·2	0·90
Wellington	58·7	2·13	1·95	6·90	$\frac{5·5-4}{1}$	8·4	0·93
Kapiti Island	76	1·94	2·30	6·60	$\frac{4-4}{1}$	8·0	1·00
Masterton	49·2	2·21	2·37	5·70	$\frac{4-4}{2}$	6·8	1·07
Wanganui	88·6	2·19	2·60	6·40	$\frac{4-4}{2}$	7·0	1·14
New Plymouth	82·6	2·08	2·32	6·30	$\frac{4-4}{1}$	7·1	1·00
Hawke's Bay	87	2·02	2·44	5·90	$\frac{3·5-3·5}{2}$	6·1	1·02
Napier	125	1·91	2·22	6·02	$\frac{4-4}{2}$	5·1	1·00
Rotorua	66·2	2·02	1·95	6·62	$\frac{4-3·5}{1}$	7·7	1·02
Rotoiti	92·7	1·98	2·25	6·30	$\frac{4-4}{1·5}$	7·1	0·96
Puriri	65·2	2·26	2·00	6·52	$\frac{3-3}{1}$	6·7	1·00
Manukau	77·5	2·16	2·67	5·10	$\frac{3-3}{1}$	5·8	1·12

TABLE 2.—Average Measurements of Specimens of *P. setosus.*

Column No.	1.	2.	3.	4.	5.	Antennal Scale.	
						6.	7.
Specimen.	Average Length.	Carapace Length ÷ Breadth.	Rostrum Length ÷ Breadth.	Rostrum Length in Body Length.	Rostrum Spines.	Length in Body Length.	Squame ÷ Peduncle.
	Mm.						
Rangiora	86·5	2·03	1·90	7·0	$\frac{4\cdot5 - 4}{1}$	8·3	0·98
Waimakariri River ..	79·7	2·03	2·16	6·2	$\frac{5\cdot5 - 5\cdot5}{1\cdot5}$	7·3	1·03
Styx River	35	2·25	2·03	5·9	$\frac{4 - 4}{2}$	6·3	1·20
Avon River	109·1	1·72	2·07	6·7	$\frac{4 - 4}{2}$	7·6	0·98
Peel Forest	78	2·02	1·92	7·0	$\frac{4\cdot4 - 4\cdot5}{1}$	8·6	0·91
Winchester	103	1·95	2·00	6·0	$\frac{5 - 4}{1}$	7·0	0·99

TABLE 3.—Average Measurements of Specimens of *P. zealandicus.*

Column No.	1.	2.	3.	4.	5.	Antennal Scale.	
						6.	7.
Specimen.	Average Length.	Carapace Length ÷ Breadth.	Rostrum Length ÷ Breadth.	Rostrum Length in Body Length.	Rostrum Spines.	Length in Body Length.	Squame ÷ Peduncle.
	Mm.						
Tinwald	138	1·82	1·70	7·5	$\frac{5 - 5}{2}$	8·6	0·85
Waimate	100	1·89	1·68	7·6	$\frac{3\cdot6 - 3\cdot8}{1}$	8·8	0·85
Glenavy	100·7	1·94	1·71	8·1	$\frac{4\cdot5 - 4}{0}$	8·4	0·87
Oamaru	59·7	2·00	1·54	7·0	$\frac{5 - 5}{2}$	7·8	1·00
Waitati	54·5	2·14	1·79	7·6	$\frac{5 - 5}{0}$	8·1	0·96
Dunedin	120	1·99	1·85	7·7	$\frac{5 - 4}{0}$	9·2	0·83
Clifden	130	1·94	1·84	7·4	$\frac{5 - 4}{2}$	8·7	0·90
Wyndham	97·6	1·98	1·62	7·6	$\frac{5 - 5}{1\cdot2}$	13	0·78



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EXPLANATION OF PLATE IV.

Fig. 1. *Paranephrops planifrons* White. Lake Rotoiti, Auckland.
Fig. 2. *Paranephrops setosus* Hutton. River Avon, Christchurch.
Fig. 3. *Paranephrops zealandicus* (White). Dunedin.

ART. XXXIII.—*A Fresh-water Crab, and its Distribution in Australia and New Zealand.*

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[*Read before the Philosophical Institute of Canterbury, 2nd November, 1914.*]

IN a small collection of *Crustacea* made towards the end of 1913 by Mr. W. R. B. Oliver on Lord Howe and Norfolk Islands there is one specimen of a small fresh-water crab, *Hymenosoma lacustris* (Chilton), which was obtained under a stone in a fresh-water stream on the top of Mount Gower, about 3,000 ft. above sea-level, in Lord Howe Island.

This crab is already known from some northern parts of New Zealand, from Norfolk Island, and from localities in Victoria, and its occurrence in Lord Howe Island is therefore of considerable importance, and affords another link in the chain of evidence that will finally lead to the explanation of its geographical distribution. A brief account of the history of this crab seems, therefore, desirable.

It was described by myself in 1882 under the name *Elamena* (?) *lacustris*, from Lake Takapuna (also called Pupuke), North Shore, Auckland. The waters in Lake Takapuna are fresh; but as the lake is only a very short distance from the seashore, and there was no similar crab then known from other fresh waters in New Zealand, I did not for some time attach particular importance to its fresh-water habitat, but considered it as being possibly a "relict" form that had only recently adapted itself to life in fresh water. A fuller knowledge of Lake Takapuna would, in itself, have shown that this view was erroneous, as will be seen from the account I give below; but at that time little was known of the fauna of the lake.

In the next year (1883), having obtained further specimens, I redescribed the species and placed it under the genus *Hymenosoma* as defined by Haswell in his catalogue of the Australian *Crustacea* published in 1882.

Nothing more was added to our knowledge of this form till the year 1901, when I received, through the kindness of Messrs. W. and R. M. Laing, specimens from fresh-water streams in Norfolk Island which appeared to me to be practically identical with the New Zealand species. About the same time Mr. S. W. Fulton, of Melbourne, obtained specimens from Norfolk Island, and also from Lake Colac, Victoria, and these, together with a single specimen collected some years previously by Dr. T. S. Hall in the Moorabool River, Victoria, also appeared to belong to the same species.

I sent New Zealand specimens to Mr. Fulton for comparison with those from the other localities, and, although he detected some slight local variations, he found that they were all so much alike that in the account published by himself and the late F. E. Grant in 1902,* he referred them all to *Hymenosoma lacustris* (Chilton).

About a year later Messrs. Lucas and Hodgkin, in their investigation of some of the fresh-water lakes of New Zealand, obtained one male and one female specimen from Lake Waikare, Auckland. These were afterwards submitted to me for examination, and in my report published in 1906† were assigned to the same species, which was therefore evidently more widely distributed in the northern part of New Zealand than I had originally

* Proc. Roy. Soc. Victoria, vol. 15 (n.s.), p. 59.
† P.Z.S., 1906, p. 702.

thought. Its area of distribution was afterwards still more extended by its discovery in the River Waipa, specimens having been sent to me from that locality by Mr. Cheeseman, and recorded by me in Trans. N.Z. Inst., 1912, p. 128.

To this must be added its occurrence in Lord Howe Island, as mentioned at the beginning of this paper. Mr. Oliver has, however, called my attention to the fact that in 1889 Mr. R. Etheridge recorded a fresh-water crab in Lord Howe Island. In his account of "The General Zoology of Lord Howe Island" (Australian Museum. Memoir No. 2, p. 34) he says, "By far the most important member of the *Decapoda* was Mr. Whitelegge's discovery of a fresh-water crab, plentifully distributed in the water-carrying gullies of the North Ridge, behind the Old Settlement, at a height of from 200 ft. to 300 ft. above high-water mark. It is a species of *Hymenicus*." This crab is recorded in the list of species on p. 36 as "*Hymenicus* sp." There can be little doubt that it is the same species as the single specimen obtained by Mr. Oliver—*i.e.*, *Hymenosoma lacustris* (Chilton).

It will thus be seen that this crab, *Hymenosoma lacustris*, is known from three localities in the north of New Zealand, from Norfolk Island, Lord Howe Island, and from two localities in Victoria, Australia, and that it is therefore a fresh-water species widely distributed in localities now separated by broad tracts of ocean.

Its true fresh-water character was not at first recognized owing to ignorance of the nature of Lake Takapuna, in which it was first found. This lake is situated very near to the sea, its eastern edge being not more than 200 ft, from the high-tide mark in Rangitoto Channel, while its western edge is within 400 yards of Waitemata Harbour; the deepest part is stated to be 168 ft., which is about 100 ft. below the bottom of the neighbouring Rangitoto Channel. It was formerly thought that there might possibly be some connection between the lake and the neighbouring sea, and it was doubted whether there was not a substratum of sea-water in the lake at depths below that of the channel. In 1899 Mr. J. A. Pond undertook the investigation of the waters of the lake, and the following facts, together with those already given, are taken from his paper published in 1900.* He took samples of the water from the surface at various distances from the margin, and also one from the pump-well at the pumping-station which supplies the suburb of Devonport. These samples were submitted to analysis, and "yielded chlorine 2·87 gr. per gallon in each instance, while the total solids at 105° C. were 8·68 gr. per gallon from the lake and Devonport samples, the pump-well 8·96 gr. per gallon." He also obtained samples from different depths—viz., 50 ft., 100 ft., 157 ft., 160 ft., and 163 ft. "The results of analysis gave chlorine 2·87 gr. per gallon, equal to chloride of sodium 4·73 gr. in each sample, while the total of solids gave 8·68 gr. per gallon in each instance, the water from the bottom of the lake being decanted from the precipitated matter. There is, therefore, not the slightest difference in these two factors of the waters at varying depths, and these agree with our analysis of samples taken at various periods."

Mr. Pond's results show the Takapuna is a genuine fresh-water lake without any connection with the neighbouring sea. This character is also confirmed by the fauna of the lake, for Mr. H. Suter, to whom I applied for information, informs me that the general fauna of the lake is decidedly

* Pond, J. A., "On the Percentage of Chlorine in Lake Takapuna," Trans. N.Z. Inst., vol. 32, pp. 241, 242.

fresh-water, no marine or relict forms being known to him. Of fresh-water *Mollusca* he has collected the following: *Potamopyrgus corolla* Gould, *Potamopyrgus corolla salleana* Fisher, *Isodora tabulata moesta* H. Adams, *Latia neritoides* Gray, *Corneocyclas novae-zelandiae* Prime, *Diplodon menziesi depauperatus* Hutton; the small fresh-water leech *Glossiphonia novae-zealandiae* Dendy was discovered in the lake by Mr. Suter, and he has several times seen in it specimens of the fresh-water crayfish *Paranephrops*.

It is therefore evident that this little crab is a genuine fresh-water species, and judging from its distribution it must be of very considerable antiquity. Owing to the difficulties of its dispersal across wide tracts of sea by ordinary means, it seems almost certain that the localities at which it is now found were formerly connected by land, though, of course, the land connections need not have been continuous throughout the whole length of its area of distribution at any one time. Nothing is yet known of the animal's life-history. Presumably it has a free-swimming zoea stage, but even if this could reach the sea from the lakes and rivers in which the adults live it is difficult to imagine how it could cross the seas and ascend other fresh waters so as to account for its present distribution. In one female from Lake Takapuna there are about twenty zoeae lying free under the abdomen of the female. They are of rather a large size for such a small crab; the abdomen is still folded under the thorax, which is fully 1 mm. in length, and they appear to have been only recently hatched from the eggs; the appendages are short and do not look as if they could be of much use for locomotion, and it is possible that in this species, as in many fresh-water forms, the young are carried about by the female for a longer time than in the case of corresponding marine species.

Its distribution is an important addition to the evidence showing connection between the north of New Zealand and lands lying farther north. A full explanation of the phenomena would involve discussion of the origin of the whole fauna and flora of New Zealand so far as the northern element is concerned, and this would be quite out of place in a paper such as this. It may, however, be desirable briefly to recapitulate what is known with regard to the distribution of other fresh-water Malacostracous *Crustacea* from New Zealand.

The New Zealand fresh-water crayfishes belong to the genus *Paranephrops*, which is confined to New Zealand, its reported occurrence in Fiji being probably due to an error in the locality labels. Three species are usually recognized, of which the one generally known as the northern form, *P. planifrons* White, is found throughout the whole of the North Island, and also from the north-western and western portions of the South Island —*i.e.*, the north of the great chain of mountains formed by the Southern Alps and their northern continuations. From the discussion of these species of crayfish as given in Mr. Archey's paper in this volume (p. 295) it will be seen that the North Island species, *Paranephrops planifrons* (White), is composed of two or three varieties, one of which is found only to the north of the parallel of latitude passing through Tauranga, its area of distribution, therefore, corresponding fairly well with the New Zealand area in which the crab *Hymenosoma lacustris* is found. The fresh-water crayfish of Australia belong to different genera—viz., *Astacopsis*, *Chaeraps*, and *Parachaeraps*. (See Geoffrey Smith, "The Fresh-water Crayfishes of Australia," P.Z.S., 1912, p. 144.)

The small New Zealand fresh-water prawn, *Xiphocaridina curvirostris* (Heller), is found in practically all suitable fresh-water streams throughout

the whole of New Zealand, and also occurs in fresh waters at the Chatham Islands. It is not known from any part of Australia, but, curiously enough, appears to occur again in Assam, specimens from this locality being in the collections of the Indian Museum, and, according to Mr. S. Kemp,* proving to be indistinguishable from those obtained in New Zealand. On the other hand, the fresh-water prawn known in Australia as *X. compressa* (De Haan) extends as far as Norfolk Island, and though it is placed by Bouvier in the same genus as *X. curvirostris* it differs markedly from that species in the character of the rostrum. *X. compressa* is a species of wide distribution, and extends from Australia right up to Japan.

The former northern extension of New Zealand which seems necessary to account for the distribution of the crab *Hymenosoma lacustris* seems also indicated by the range of the large land-shell *Placostylus*,† a genus which is represented by two species in the north of New Zealand, and by others in Lord Howe Island, New Caledonia, New Guinea, Fiji Islands, New Hebrides, and Solomon Islands, and by the fact that the predominant earth-worms in the North Island belong to the subfamily *Megascolecinae*, which is characteristic of Australia and Tasmania, and is also represented in Norfolk Island.‡

I append the following brief description :—

Hymenosoma lacustris (Chilton).

Elamena (?) *lacustris* Chilton, Trans. N.Z. Inst., vol. 14, p. 172.
Hymenosoma lacustris Chilton, *l.c.*, vol. 44, p. 128 (with synonymy).

The chief points in the description of this crab may be given as follows :—

Carapace nearly circular, rather broader than long ; flat, naked, or with a few scattered hairs. Rostrum broad, strongly depressed, its upper surface

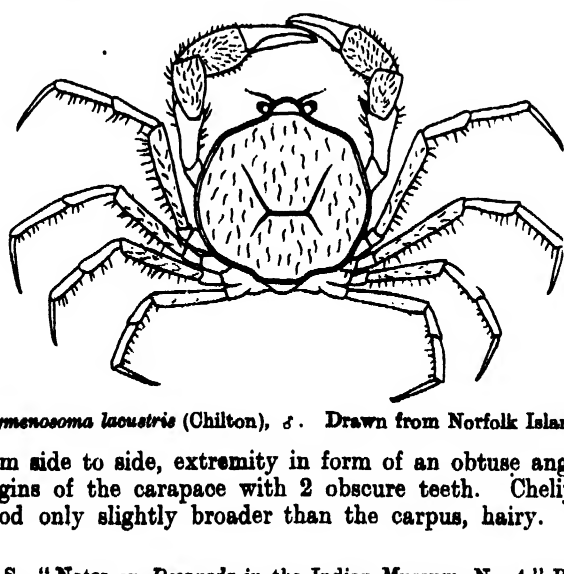


FIG. 1.—*Hymenosoma lacustris* (Chilton), ♂. Drawn from Norfolk Island specimen.

concave from side to side, extremity in form of an obtuse angle. Antero-lateral margins of the carapace with 2 obscure teeth. Cheliped of male small, propod only slightly broader than the carpus, hairy. Ambulatory

* Kemp, S., "Notes on *Decapoda* in the Indian Museum, No. 4," Records Indian Museum, vol. 7, p. 113.
† Suter, H., "Manual of the New Zealand *Mollusca*," p. 763.
‡ Benham, W. B., Trans. N.Z. Inst., vol. 37, p. 282, and vol. 35, p. 273.

legs somewhat densely covered with long hairs, tarsi long, slender, compressed, densely haired. Last pair of legs somewhat shorter than the preceding. Abdomen of male of 5 joints subequal in length, 3rd rather narrower than the 1st and 2nd, 4th nearly as wide as the 3rd, last broadly rounded at the end; margin fringed with very short hairs, some longer ones being scattered on the surface. Abdomen of female with slight median ridge along its whole length.

Fulton and Grant have pointed out that the specimens from different localities differ slightly as to the prominence of the obscure teeth on the margin of the carapace, the hairiness of its surface, and the small teeth or tubercles on the wrist and hand of the cheliped of the male. These features were, however, found not to be constant, and I agree with them in considering all the forms as belonging to one species. Even if it should be necessary for systematic purposes to distinguish local varieties, it would not affect the importance of the fact that the same fresh-water crab is found in several lands now widely separated by sea.

Art. XXXIV. *The New Zealand Species of the Amphipodan Genus* Elasmopus.

By Charles Chilton, M.A., D.Sc., M.B., C.M., LL.D., F.L.S., Professor of Biology, Canterbury College, New Zealand.

[*Read before the Philosophical Institute of Canterbury, 2nd December, 1914.*]

In "Das Tierreich" *Amphipoda Gammaridea* Mr. Stebbing describes nine accepted species of the genus *Elasmopus* and four doubtful ones. Of these, two are recorded as having been found in New Zealand seas -viz., *E. subcarinatus* (Haswell) and *E. viridis* (Haswell)—both of which were also known from Australia, and were originally described in 1879 from Australian specimens. In the case of the first species, which had been redescribed by Mr. G. M. Thomson in 1882 under the name of *Maera petriei*, I pointed out many years ago that there were two forms of male apparently both belonging to this species, but no fuller investigation of the matter has yet been made, although in the meantime the species has been recorded from the shores of Ceylon and other places in the Indian Ocean. In the endeavour to work out an Australian species of *Elasmopus* I have been led to look into the New Zealand species, and the following notes are the result.

The genus appears to be closely allied to *Maera*, and in some cases it will probably be difficult to decide in which of the two genera a particular species should be placed. The species *E. subcarinatus* and those allied to it appear to be distinguishable from *Maera* by the small accessory flagellum, the robust peraeopoda, and by the third uropod not reaching far beyond the others.

I have not included *Maera viridis* (Haswell), which Stebbing has placed under *Elasmopus*, as it differs in several respects from the other species, and appears to me to be very close to *Maera inaequipes* (A. Costa) and best left under *Maera*.

So far as the New Zealand forms are concerned, the characters which seem most useful for distinguishing the species are whether the pleon is carinated or not, the character of the carination when present, and the shape of the second gnathopods in the male. The second gnathopoda are usually much more largely developed in the males than in the females, and their distinctive characters appear to be attained only in fully developed males, so that the particular form of gnathopoda may vary considerably owing to the age and development of the animal; and from what has been stated below it seems probable that in one species there are two forms of gnathopoda in the adult males, apparently similar to what has been described by Mrs. E. W. Sexton in the case of *Jassa falcata* (Montagu). In these cases it is, of course, difficult to decide whether we are dealing with one species with two forms of male, or with two different species in which the females are practically indistinguishable although the males are different. In the following list I have treated the forms as belonging to separate species, except in the one case where the differences between the males are confined to the second gnathopoda.

Elasmopus subcarinatus (Haswell). Figs. 1–6.

Megamoera subcarinatus Haswell, 1879, p. 335, pl. 21, fig. 4. *Moera petriei* G. M. Thomson, 1882, p. 236, pl. 18, fig. 3; Chilton, 1883, p. 82, pl. 2, fig. 4*a*. *Moera subcarinata* Chilton, 1884, p. 230; 1884A, p. 1039; and 1885, p. 368. *Elasmopus subcarinatus* Stebbing, 1906, p. 441 (with synonymy); 1910A, pp. 602 and 643; 1910B, p. 457: Walker, 1904, p. 275, pl. 5, fig. 34; 1909, p. 335.

The history of this species is briefly as follows: It was described in 1879 by Haswell from specimens obtained at Port Jackson, where it is common. He described only the male, and says the pleon is "dorsally carinate, the carina projecting posteriorly in the form of a compressed tooth," though it is really bicarinate, each carina ending in a tooth. In 1882 Thomson independently described the species under the name *Maera petriei* from two specimens from Stewart Island, New Zealand, correctly describing the "fourth segment of the pleon produced into two acute spines [teeth] on its postero-dorsal border"; his description applies to the male only. Shortly afterwards I obtained specimens in Lyttelton Harbour that I identified with *Maera petriei* Thomson, and in 1883 I described and figured the second gnathopod of the female, and at the same time pointed out that the males from Lyttelton differed from the description given by Thomson in the shape and hairiness of the second gnathopoda. A little later I collected in Port Jackson specimens that I had no hesitation in identifying with *Megamoera subcarinata* Haswell, the type of which came from that locality. The females were quite like those from Lyttelton which I had assigned to *Maera petriei*, and the males agreed with the description given by Thomson, thus differing slightly from those I had obtained at Lyttelton. Accordingly I united the two species, and drew attention to the fact that there appeared to be two forms of the male (1884A, p. 1039, and 1885, p. 368). The "Challenger" Expedition obtained two specimens from Station 168, off New Zealand, and in 1888 Mr. Stebbing, after comparing these with specimens of *Maera petriei* sent by me from Lyttelton and with Thomson's description, withdrew the specific name *persetosus*, under which he had commenced to describe them as a new species, and assigned the "Challenger"

specimens to Haswell's species, accepting the view that the males presented some variety of form in the second gnathopoda. The form described and figured by him closely corresponds with that of my Port Jackson specimens. He placed the species under the genus *Elasmopus* Costa.

In 1904 Walker referred specimens from Ceylon to *Elasmopus subcarinatus* (Haswell), drawing attention to differences among them in the second gnathopoda of the male, all of them having the hind margin densely setose, but none being quite like the one figured by Stebbing in the "Challenger" Report. In 1909 he assigned specimens from Cargados, in the Indian Ocean, to the same species; in these he says the wrist and hand of the second gnathopoda of the male "have an inflated appearance, and are almost naked. It appears to be the form described by Chilton (Proc. Linn. Soc. N.S.W., vol. ix, part 4) under *Moera petriei*, which he unites with this species; it is probably a condition of immaturity." In 1910 Stebbing recorded the species from Cape Colony, and says that a small male has the second gnathopod agreeing with that described and figured by Walker in 1904 from a Ceylon specimen.

If the specimens from these different localities are all rightly referred to *Elasmopus subcarinatus*, the species is a widely distributed one in Indian and Southern Oceans, and presents considerable differences in the form of the second gnathopoda of the male. I have never felt quite certain whether these differences were merely stages of growth in the development of the mature form, or whether we were dealing with a species with dimorphic males, or, again, with two different species with similar females but different males. Caution is necessary in coming to a conclusion, for there are other closely allied species of *Elasmopus* with male gnathopoda not unlike the setose form described by Thomson, Stebbing, and Walker; thus New Zealand specimens that I at first sight thought belonged here prove to differ also in the carination of the pleon, and to belong to the species *E. neglectus*, described below. Nearly all the forms I have personally collected in New Zealand have the male gnathopoda like that described by me under *Maera petriei*—*i.e.*, not densely fringed with long slender hairs. Thomson's Stewart Island specimens, on the other hand, have the gnathopoda densely fringed, as in the Port Jackson and "Challenger" specimens, and I have a similar specimen from Moko Hinou; so that the two forms do occur in New Zealand, and if Walker's identification of the Cargados specimen is correct the two forms also occur in the Indian Ocean, though they apparently have not been taken together. In the typical adult male second gnathopod as figured by Stebbing in the "Challenger" Report the palm shows distinct teeth and the hind margin in densely setose; in adult forms like this the posterior peraeopoda are particularly stout, and their terminal joints very setose. In younger specimens transitional stages in the development of these two characters are to be found, and the forms described by Walker, Stebbing, and Thomson are, I think, males of this form, some of them not yet fully developed, in which the teeth on the palm are less prominent, though the long slender setae are already present. In the gnathopod of the males described by me under *Maera petriei* the palm is differently toothed, and the long slender setae are entirely absent, though a few ordinary setae are present. This form occurs in specimens quite as large and apparently as fully developed as those with the setose gnathopoda, and from their difference in shape it is, I think, impossible to look upon them as stages leading up to the fully developed setose form. I consider them to be a different form of the male,

but, as in the carination of the pleon and in all other characters they are so closely similar, I consider them as belonging to the same species (*Elasmopus subcarinatus*). It is possible, as I pointed out in 1885, that the two forms are alternating forms of the male, the setose one assumed during the pairing season and the other during the periods between the pairing seasons—in this respect resembling the alternating forms described by Faxon in some species of *Cambarus*. I suggest the setose form as the one assumed during the pairing season, because similar long slender setae are found as a distinctive male character in many *Amphipoda*, *Isopoda*, and other *Crustacea*, and it is possible that they are sensory and of special use during the pairing season. This explanation would perhaps also account for the fact that all the males collected at any one time appear to belong either to one form or the other, and that the two are not taken together, though, of course, this and the fact that the non-setose form has not yet been recorded from Australia would be more easily accounted for on the supposition that we have two distinct species to deal with. However, Mrs. Sexton's results, which prove that in *Jassa falcata* (Montagu) two forms of male occur, changing at certain moults, induce me to think that we have only one species here also.

This species has been very fully described by Stebbing in his report on the "Challenger" *Amphipoda*, and the following brief description, based upon his shorter diagnosis in "Das Tierreich," *Gammaridea*, will be sufficient here.

Specific Diagnosis.

Female with fourth pleon segment bicarinate behind the dorsal depression, each carina ending in an acute tooth; third pleon segment with postero-lateral corner acutely produced. First antennae elongate, sometimes as long as the body, first joint about as long as the second but stouter and

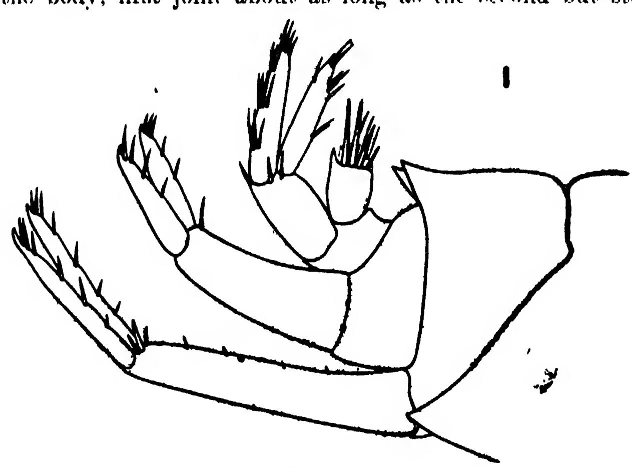
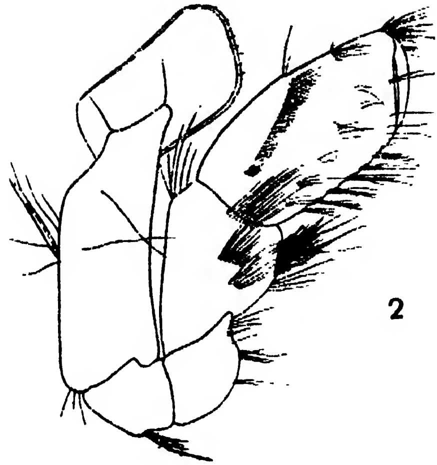


FIG. 1.—*Elasmopus subcarinatus*, male. Terminal portion of pleon with uropoda and telson.

bearing stout setae on the lower margin, third joint half as long as the second, flagellum longer than the peduncle, markedly setose, accessory flagellum well developed with six joints or less. Second antennae not much longer than the peduncle of the first, ultimate joint of peduncle shorter than the penultimate, flagellum shorter than peduncle.



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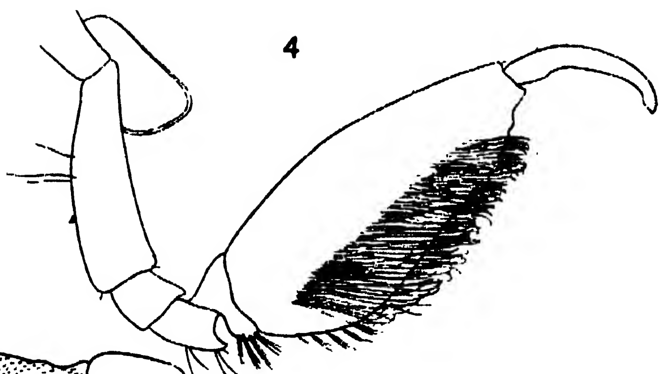

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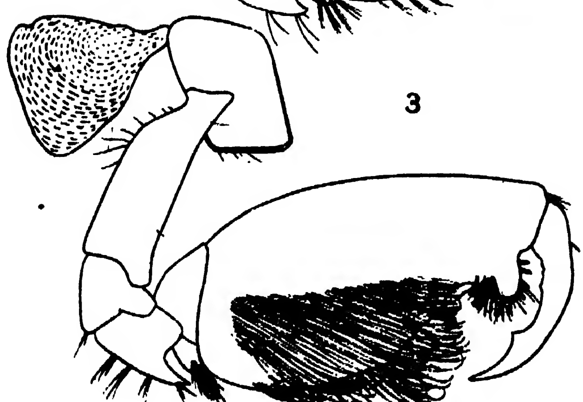

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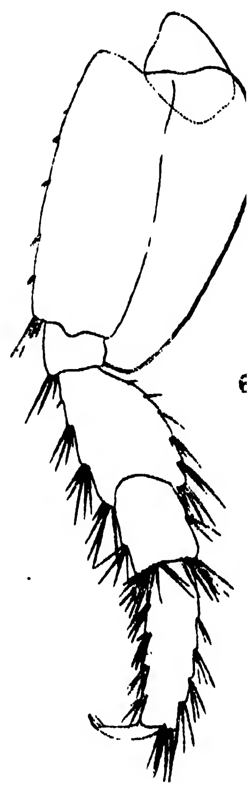
FIG. 2.—*Elasmopus subcarinatus*. First gnathopod.
FIG. 3.—*Elasmopus subcarinatus*, male, form 1. Second gnathopod of fully developed male.
FIG. 4.—*Elasmopus subcarinatus*, male, form 1. Second gnathopod of immature male.

Mandible with third joint of palp slender, its hind margin straight, front margin sparsely setose, not pectinate. First gnathopoda setose; ischium ending acutely; carpus not much shorter than propod, with numerous tufts of slender setae on its inferior margin and lower surface; propod oblong with palm slightly oblique, inner surface bearing a well-marked oblique comb-like row of short stout setae increasing in length towards the distal end of the row and numerous transverse rows or tufts on the hind margin and adjoining inner surface, also three similar transverse rows on the distal half of the anterior border, the third being at the base of the dactyl. Second gnathopoda similar in general form to the first, but larger; carpus longer than broad, fully half as long as the propod, both with numerous tufts of setae arranged on the whole as in the first gnathopod but without the charactertistic comb-like row on the inner surface of the propod.

Peraeopoda rather stout, basal joint rounded-oblong and well expanded, posterior margin simply serrate. Telson about as long as peduncle of third uropod, each lobe bearing three or four long setae at extremity and having the outer angle acutely produced.

Male differing from female in the second gnathopoda and the peraeopoda. The peraeopoda, especially the *fifth*, are stouter and more setose, but the posterior margin of the basal joints is only slightly serrate with long flat serrations; merus, carpus, and propod broadened and densely setose.

In the gnathopoda there are two forms. In form 1 the basal and ischial joints have the outer margins produced into a thin flat flange, especially at the distal end, and the anterior surface hollowed to received the greatly enlarged propod when it is bent back on them; ischium produced distally into an acute point; carpus very short, cup-shaped, its posterior border forming a densely setose lobe; propod very large, broader than the carpus, fringed behind with long slender setae partially arranged in



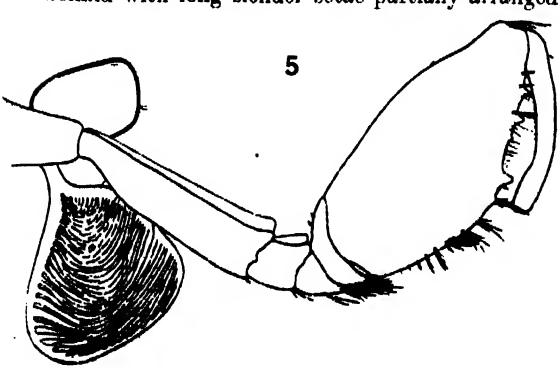


FIG. 5.—*Elasmopus subcarinatus*, male, form 2. Second gnathopod.
FIG. 6.—*Elasmopus subcarinatus*. Fifth peraeopod.

transverse rows, palm in fully developed individuals with a broad spinulose process near the finger-hinge followed by a deep cavity, a strong tooth, a feeble oblique emargination, and a defining denticle; dactyl stout, strongly bent, minutely dentate near the base, with a large triangular process opposite the central palmar tooth, apex subacute reaching the palmar denticle.

Form 2 is similar to form 1 except in the propod and dactyl. The propod is quite devoid of long slender setae, and has only a few small tufts of setae of the usual kind on the posterior margin; the palm bears three prominent teeth, between which are some smaller denticles, with a few scattered setae; dactyl broad with bluntly rounded apex, its inner margin slightly uneven but without denticles or processes.

Colour whitish.

Length, up to 15 mm.

Distribution.—Shores of New Zealand, Australia, Ceylon, South Africa, and Indian Ocean. Usually found at or below low-water mark.

In New Zealand this species occurs at moderate depths in all suitable localities from the Three Kings to Stewart Island. I recently obtained it with the dredge at a depth of 60 fathoms at the Three Kings and at another station about half-way between the Three Kings and Cape Maria van Diemen.

Remarks. Immature males are more like the females, the characters of the gnathopoda and the broadened setose peraepoda being fully acquired only in adult males. In immature specimens of form 1 the propod of the second gnathopod may be densely haired, but the teeth and processes on the palm much less developed or even absent, and the dactyl without the denticles and process.

In addition to New Zealand specimens, I have been able to examine others from Sydney Harbour (collected by myself in 1884); from St. Vincent Gulf, South Australia (S. W. Fulton); and from Tasmania and Bass Strait (F.I.S. "Endeavour"). In all of these the males are of form 1. The "Endeavour" specimens are a little more slender than some of the others, and rather more setose, bearing a few long scattered setae on the dorsal surface of the peraeon and pleon. In the Sydney and New Zealand specimens the setae on the dorsal are scanty and small.

Elasmopus neglectus sp. nov. Figs. 7–10.

Male.—Third pleon segment with postero-lateral corner acutely produced; fourth segment with a single dorsal carina, ending posteriorly in

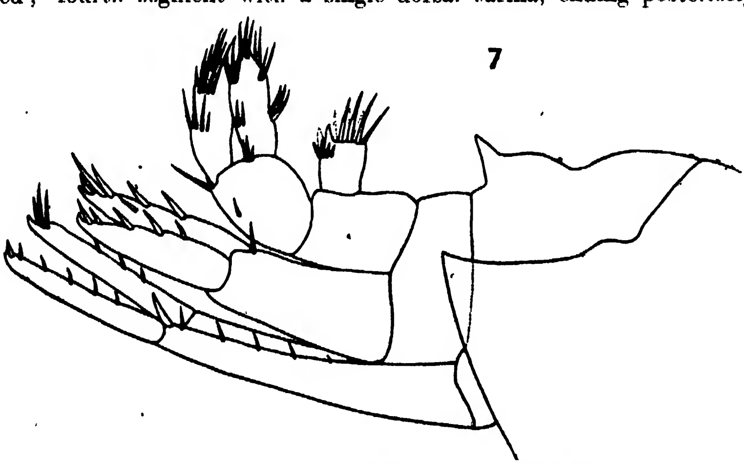
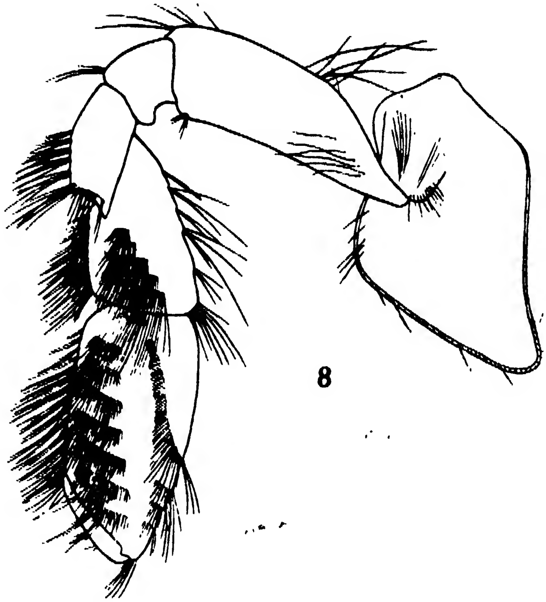


Fig. 7.—*Elasmopus neglectus*, male. Terminal portion of pleon, with uropoda and telson.

an acute point. Mandible with third joint of palp slender, its hind margin slightly convex, front margin pectinate. First gnathopod with side-plate produced anteriorly into a rounded lobe, the terminal joints densely setose

as in *E. subcarinatus*. Second gnathopod very large, ischium ending acutely, carpus short cup-shaped with densely setose posterior lobe, propod very



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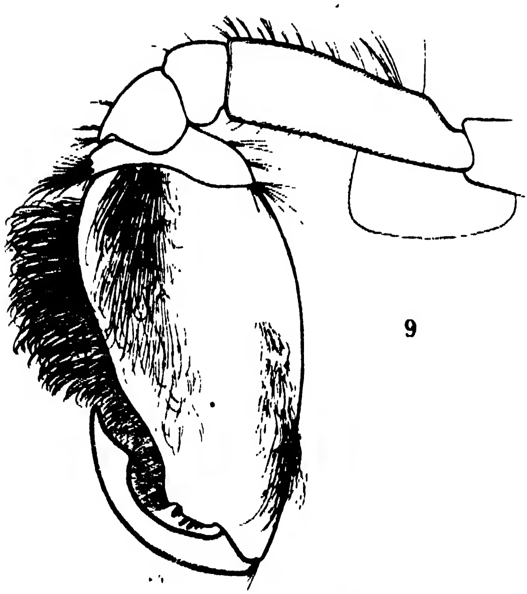

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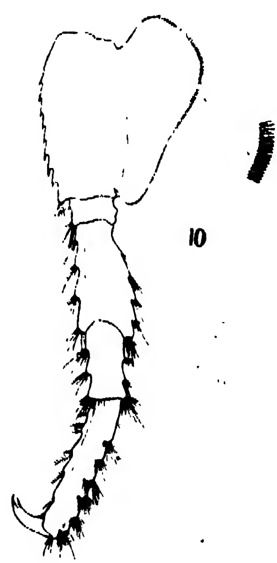

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FIG. 8.—*Elasmopus neglectus*, male. First gnathopod.
FIG. 9.—*Elasmopus neglectus*, male. Second gnathopod.
FIG. 10.—*Elasmopus neglectus*, male. Fifth peraeopod.

large, broadest proximally narrowing towards the distal end, palm long oblique not defined and with only a poorly marked spinose lobe near the

finger-hinge, whole lower margin and greater part of the propod densely fringed with long slender setae mostly arranged in transverse tufts and rows; dactyl stout, its inner margin smooth, with a broad triangular process towards the subacute apex. Peraeopoda stout and broad and very densely setose, especially the fifth, posterior margin of basal joint regularly pectinate the pectinations longest towards proximal end.

In other characters closely resembling *E. subcarinatus.*

Female.—Fourth segment of pleon with single dorsal carina as in the male. First gnathopod similar to that of male, but with side-plate not appreciably produced anteriorly. Second gnathopod considerably larger than the first but similar in general shape, merus ending acutely, carpus about one-third as long as propod, which is only slightly broader than carpus, whole propod densely setose, the long setae being arranged in transverse tufts and rows, other long slender setae are present apparently similar to those found in the male, palm very oblique defined by one or two stout spinules and with a small spinose process near the finger-hinge; dactyl normal, its inner margin smooth and without protuberance, apex acute. Peraeopoda with posterior margin of basal joints simply serrate.

Colour whitish.

Length, up to 15 mm.

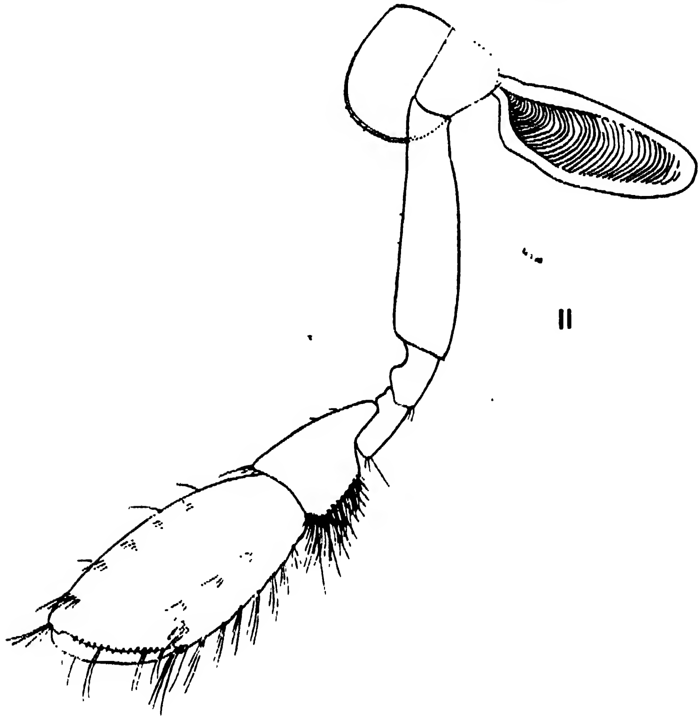
Distribution.—Blueskin Bay, Otago (G. M. Thomson); Moko Hinou (C. R. Gow). Probably widely distributed on New Zealand coasts.

Remarks.—The description of the second gnathopod of the female is taken from an ovigerous specimen. It is interesting to note that it shows more resemblance to the corresponding appendage in the male than is the case in *E. subcarinatus.* The special characters of the second gnathopods and the peraepods in the males are fully marked only in mature specimens; immature males are more like the females.

Elasmopus bollonsi sp. nov. Figs. 11, 12.

Male.—Third segment of pleon with posterior corner rectangular, not produced, lower portion of posterior margin with small serrations. Fourth segment of pleon smooth and without dorsal carina. First antenna elongate, second antenna with peduncle shorter than that of first, both with numerous long setae and in general resembling the antennae of *E. subcarinatus.* Mandible with third joint of palp not very slender, hind margin convex, front margin pectinate. First gnathopod shorter than in *E. suboa inatus* and much less setose but with the oblique pectinate row on the inner surface of the propod and with the other setae arranged on the whole as in that species, basal joint stout, merus not ending acutely, carpus as long as the ovate propod. Second gnathopoda unequal, the right one similar to the first but larger, propod nearly twice as long as carpus, setae normal, left gnathopod with basal joint, ischium, and merus all small, carpus small triangular fitting into the outline of the propod which is very large, longer than the rest of the appendage, and abnormally shaped forming with the dactyl an irregular oval, setae few short and scattered, anterior margin sinuous, palm oblique defined by a bluntly rounded lobe and forming a depression on the inner side of the propod, near the finger-hinge is a small flat-topped tooth followed by a larger one of similar shape and then a low convex swelling, dactyl broad with blunt

extremity. Peraepoda fairly stout, with long setae, posterior border of basal joint serrate. Third uropoda short, not much longer than the telson.



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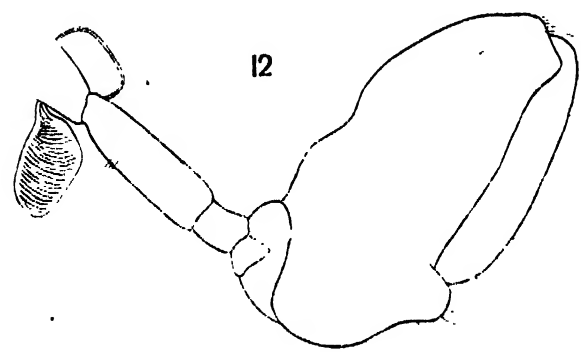

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FIG. 11.—*Elasmopus bollonsi*, male. Right second gnathopod, seen from inner side.
FIG. 12.—*Elasmopus bollonsi*, male Left second gnathopod, seen from inner side. (The teeth on the palm are concealed by the dactyl.)

Female resembling the male, except in the second gnathopoda, which are of normal form.

Colour whitish.

Length of male, 8 mm.

Habitat.—Dredged off the Three Kings Islands, north of New Zealand, at a depth of 60 fathoms.

Remarks.—This specimen was obtained when the present paper was almost completed. I have only one male and two small female specimens, and have not had time to make a full examination of them. It appears to be a true *Elasmopus*, coming fairly close to the three species described above, but readily distinguished from them by the absence of carination on the fourth pleon segment and by the very peculiar left second gnathopod in the male.

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ART. XXXV.—*Notes from the Canterbury College Mountain Biological Station, Cass.*

No. 1.—INTRODUCTION AND GENERAL DESCRIPTION OF STATION.

By CHARLES CHILTON, M.A., D.Sc., M.B., C.M., LL.D., F.L.S., Professor of Biology, Canterbury College, New Zealand.

[*Read before the Philosophical Institute of Canterbury, 2nd December, 1914.*]

Plates V, VI.

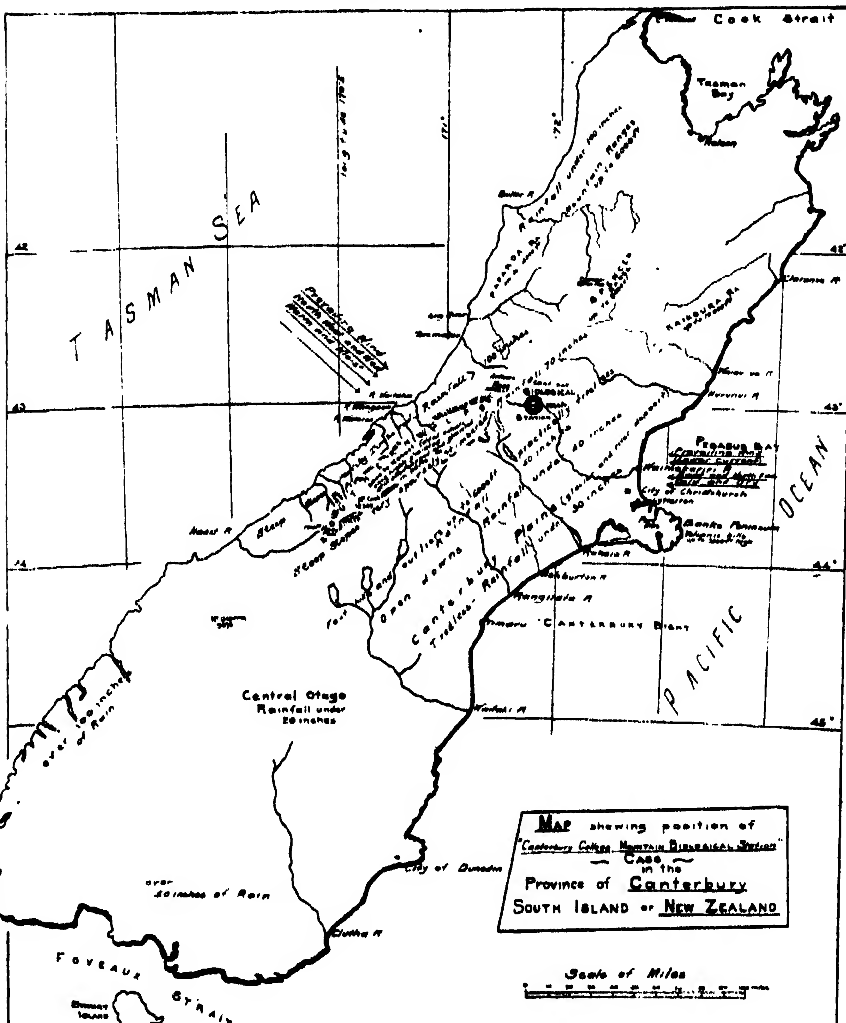
THE time when it was thought that the work of the university both in teaching and in research could be adequately carried out within the four walls of a lecture-room has long since passed. For science subjects, and especially for those generally known as the natural sciences—*i.e.*, zoology, botany, and geology—the work has already extended far beyond the university buildings, and, in addition to the ordinary laboratories, advantage has been taken of excursions to points of interest for the particular science concerned. Gradually, however, it has been found that such short visits are insufficient for the full prosecution of many lines of research, and that even for teaching purposes it is desirable to have stations situated far from the ordinary university buildings, at places where the animals, or plants, or rocks can be readily studied under the actual conditions in which they occur in nature. Some of these biological stations were originally established independently of any university, as, for example, the first one at Naples, and for a time they were confined almost entirely to marine biological stations, and these still form the great majority. The advantages of such stations to the universities were, however, soon appreciated, and most of the leading universities now either have biological stations of their own or have made arrangements to secure accommodation whenever it may be required for their students at stations controlled by other authorities.

Soon, too, stations other than marine began to be established; one of the first of these, perhaps, was the pioneer fresh-water station, established by Professor Zacharias at Plön, in East Holstein, Germany. Mountain stations, more particularly designed for the study of alpine plants and the comparison of them with those of the lowlands, have also been established by the Universities of Munich, Zurich, and many others; while in America, in addition to mountain stations, there is at least one special station for the study of the botanical and other features presented by a desert locality.

The credit of first suggesting a mountain biological station in connection with Canterbury College is due to Dr. L. Cockayne, F.R.S. From his residence for a time on the West Coast Road on the borders of Westland, and from his frequent visits to these mountainous and alpine regions, the facilities that they offered for extending the work and the research connected with the biological laboratory impressed itself upon him, and in the year 1908 he suggested to the Board of Governors of the College the desirability of reserving an area as a botanical reserve, and erecting on it a suitable building for the accommodation of students and others engaged in natural-history research.

At first he suggested a locality on the Craigieburn Run, one of the educational reserves belonging to the College, about a mile and a half from the railway-station that then existed near the railway-bridge across the Broken River. The suggestion for a biological station was strongly supported by myself, to whom it was referred by the Board of Governors, and

it also received very cordial approval from the Board. Before anything definite was done, however, the railway was extended considerably beyond Broken River and the temporary station was removed, and early in 1910, on the suggestion of Mr. R. Speight, now Curator of the Canterbury Museum, who was well acquainted with the neighbourhood in question, it was thought



MAP OF SOUTH ISLAND OF NEW ZEALAND, SHOWING POSITION OF THE CANTERBURY COLLEGE MOUNTAIN BIOLOGICAL STATION. (Prepared by Mr. W. F. Robinson.)

that it would be better to select an area farther along the railway, nearer the Cass River and railway-station. Accordingly, in 1910, the district was visited by Mr. C. H. Opie (member of the Board of Governors), Mr. G. H. Mason (Registrar), Mr. R. Speight, and myself, and we were fortunate in finding an area on the Grasmere Run, another educational reserve in the possession of the College, quite close to the Cass Station, which included

Fig. 1.—Station Building seen from the North-east.

Fig. 2.—General View.

Canterbury College Mountain Biological Station, Cass.

two or three patches of beech forest, a rocky knoll, hill slopes, a creek and swamp, and also a portion of a large shingle-fan now well covered with vegetation. On our recommendation the governing body of the College, with great liberality, arranged for the reservation of an area of approximately 200 acres to include these features, and also set apart a sum of £200 for the erection of the necessary building. In due time plans and specifications were drawn up, and the building was erected under the superintendence of the officers of the Public Works Department, who were then engaged in forming the railway between the Cass Station and the foot of Arthur's Pass. The building was completed towards the end of 1912, and has since been fitted up with the necessary furniture and equipment, and at the beginning of 1914 was first definitely used for the purpose for which it was erected. During this year I visited it and spent some time at it on several occasions, sometimes with students, and sometimes without, and it is now completely ready for use in connection with the work of the biological laboratory.

The boundaries of the botanical reserve at the station have not yet been actually defined and surveyed, but this will be done later, and a botanical map of the district prepared. In the meantime the following notes will perhaps be sufficient to give an idea of the station and of its suitability for the work for which it is intended.

The reserve is situated quite close to the Cass Railway-station, the building being only about 200 yards from the station. The height above sea-level is 1,850 ft. The area included in the reserve comprises a portion of a swamp with a fresh-water stream, a rocky knoll with hilly slopes, two or three small patches of beech forest in one of the valleys, and several fine native shrubberies in some of the gullies. There is also included the greater part of a large shingle-fan about a mile and a half across and a mile wide, formed by the detritus from a neighbouring mountain known locally as the "Sugarloaf"; and access is provided to Lake Sarah, one of the numerous mountain lakes in the district, Lake Sarah itself being only a mile and a half from the station.

The shingle-fan is an old one, and is now well covered with vegetation of the usual tussock-meadow formation, containing among the tussocks a very large variety of cushion plants, such as *Scleranthus biflorus*, various species of *Raoulia*, cushion forms of *Carmichaelia*, *Coprosma*, &c. The cushion plants are very abundant both on the shingle-fan and in the neighbouring river-beds; two of the most striking of them are perhaps two species of *Coprosma*, *C. repens* and *C. Petriei*, both forming extensive mats on the surface, which in autumn are thickly studded with the large translucent berries, port-wine-coloured in the first, pale blue in the second. Observations and experiments on these cushion plants open up a fascinating line of study for the ecologist.

Quite near to the building are many large plants of the "wild-irishman" (*Discaria toumatou*), which has already become well known through Dr. Cockayne's classic experiment, proving that the spines on it are not developed if the plant is grown in a moist, damp, still atmosphere. The peculiar umbelliferous plant *Aciphylla squarrosa* is also abundant, and there is a large variety of shrubs belonging to the genera *Aristotelia*, *Corokia*, *Coprosma*, *Hymenanthera*, &c. In the autumn the berries on these attract the visits of numerous native and introduced birds.

The flora of Lake Sarah and of its shores is well worthy of being fully investigated. In the lake is an abundance of *Isoetes*, *Pilularia*, *Potamogeton*, and a *Nitella* which grows in the deeper waters of the lake at some little

distance from the margin. Besides the old shingle-fan on which the station building is erected, there are at short distances in the neighbourhood various other fans of different ages, some only recently formed and still quite bare, others in different stages of being covered with vegetation. Near by, also, are the large river-beds of the Cass and the Waimakariri Rivers, affording ample opportunity for investigation of their peculiar vegetation. Several mountains from 3,000 ft. to 5,000 ft. high are accessible at short distances from the station, while a little farther off are many others of greater height with their summits almost constantly snow-clad. On these moun tains are numerous "shingle-slips," with their characteristic vegetation. Arthur's Pass, with its rich profusion of alpine plants, can be readily reached by a short train journey, and its vegetation could be studied with the greatest ease, using the Mountain Biological Station as the base. Across the Waimakariri River, only a few miles from the station, is the great Waimakariri National Park, with its extensive beech forests, steep valleys and snow-clad hills kept moist with the constant rainfall, and providing a wonderful variety of mosses, liver-worts, and lichens.

Altogether it will be seen that the mountain station at the Cass provides opportunity for a more varied and extensive study of different kinds of vegetation than is likely to be met with in a similar area in any part of the world.

The fauna of the district is less conspicuous, and appears to be little varied; but, although they are not very prominent, there are numerous insects on the open country, and in the neighbouring bush a considerable variety of insects, spiders, Myriapods, and other invertebrata; while Lake Sarah and the other lakes that are within easy reach will afford plenty of material for the study of their plankton forms.

The whole of the reserve has been used as part of a sheep-run, sheep being still pastured on it, and in accordance with the usual custom the tussocks have been periodically burnt off in some areas. When portions of the reserve are fenced off and the tussocks allowed to grow undisturbed it will be possible to see how far the vegetation has been affected by the treatment it has received in the past, and to make definite experiments as to the best methods of preserving the natural pasture of the runs or of improving it. A number of the introduced plants that usually spread rapidly in New Zealand have made their appearance on the shingle-fan and in the river-beds, but they are for the most part small and inconspicuous, and fortunately no gorse, broom, or other obnoxious shrubs have as yet established themselves on the reserve.

No definite records are yet available with regard to the meteorology of the Cass Station. It lies at an altitude of 1,850 ft. above sea-level, in one of the intermontane basins of Canterbury, and is surrounded at a distance of from three to six miles by several peaks rising to a height of 4,000 ft. to 5,000 ft. On the north and north-west, at no great distance, lie the mountains forming the main chain of the Southern Alps, separated from the station, however, by the broad valley of the Waimakariri; to the south and south-east, beyond Castle Hill, Mount Torlesse, and other outliers of the main range, lie the extensive treeless plains of Canterbury at a considerably greater distance.

The air is bright and clear, and on fine days the solar radiation is very great, while at night cooling rapidly takes place, especially in those parts which lose the sun early in the shadow of the hills. Frosts are frequent practically throughout the summer: there was a sharp frost on the 8th March, 1915. The prevailing wind is from the north-west, which deposits

Fig. 3.—Station Building seen from the South-west.

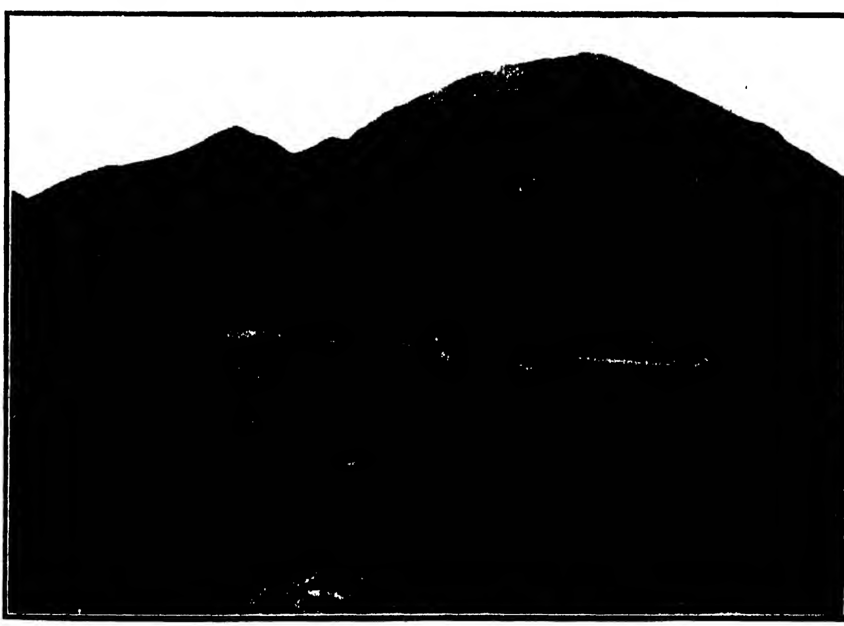


Fig. 4.—View of Shingle fan, looking towards Mount Sugarloaf.

Canterbury College Mountain Biological Station, Cass.

its moisture in heavy rainfall on the western slopes of the Southern Alps. At the Cass the wind, though fairly dry, is still cool; it is often strong, and is frequently accompanied with showers of rain, with corresponding effect on the vegetation. Farther to the east the wind continues, soon assuming the dry hot character that makes it so disagreeable on the Canterbury Plains. The station is fairly well protected from the cold south-west winds.

In the winter snow frequently falls, and may cover the ground for some days, but it seldom lies for any long period of time. The ground around the station was covered with a thin coat of snow on the 13th June, 1914, and there were two slight falls towards the end of November in the same year. The neighbouring hills are, of course, much more frequently covered with snow which remains on them for much longer periods than on the lower portions.

The building that has been erected is a substantial cottage, strongly built to withstand the prevailing north-west winds. It contains a large living-room, with fireplace, cooking-appliances, &c., and is fitted with cupboards and shelves and the necessary accommodation for field laboratory work. There is a sleeping-room with bunks capable of accommodating eight students, and a small room with two bunks for the teachers or leaders of the parties. It is hoped in time to form at the station a small working library of books required for field-work, and collections of preserved material of plants and animals from the surrounding districts which could be worked up either at the station itself or elsewhere. The station can be readily reached from Christchurch by a train journey of about four hours' duration. At present the train service is on alternate days only, but probably before long there will be a daily service.

The foregoing account will, I think, show that the Canterbury College Mountain Biological Station is eminently suited for the purpose for which it was established, and that the vegetation of the surrounding district offers great opportunities and many problems to the botanists of the future. There is every reason for hoping that by the students of the College and by other workers there will be produced a long series of notes embodying the results of observations and experiments made at the station, and that the expense of its establishment and maintenance will be far more than repaid by the value of the results attained.

I am greatly indebted to Mr. W. F. Robinson, Lecturer on Surveying at the School of Engineering, Canterbury College, for the preparation of the map accompanying this article, and to Messrs. Foweraker and Nelson for the photographs.

DESCRIPTION OF PLATES.

PLATE V.

Fig. 1. The station building seen from the north-east; behind is the railway-station, and in the distance the valley of the Cass. (P. S. Nelson, photo.)

Fig. 2. General view; showing the swamp and Grasmere Stream in the foreground, the shingle-fan with the station building on the right, and the snow-clad mountains beyond the River Waimakariri in the distance. (P. S. Nelson, photo.)

PLATE VI.

Fig. 3. The station building seen from the south-west, with the patches of beech forest behind. (C. E. Foweraker, photo.)

Fig. 4. View of the shingle-fan, looking towards Mount Sugarloaf: tussock, *Aciphylla squarrosa*, and *Discaria toumatou* in the foreground; beech forest and mountain scrub in the distance. (C. E. Foweraker, photo.)

Art. XXXVI.—*The Intermontane Basins of Canterbury.*

By R. Speight, M.Sc., F.G.S.

[*Read before the Philosophical Institute of Canterbury, 1st July, 1914.*]

[For important places mentioned in this article, see accompanying map.]

In his admirable paper on the "Physiography of the Middle Clarence Valley," published in the *Journal of the Royal Geographical Society*, September, 1913, Mr. C. A. Cotton discusses the origin of the Kaikoura Mountains, and considers that their main features have resulted from the following sequence of events: (1) Denudation of a deformed mass of Triassic rocks; (2) deposition of the covering strata; (3) orogenic uplift; (4) a cycle of erosion which he terms the "great denudation"; (5) regional uplift of relatively small amount; (6) renewed denudation.

From this it is apparent that the author considers the area now occupied by the Kaikouras to have been covered by the sea in early Tertiary times, and that during this submergence a veneer of relatively weaker beds was laid down over these older rocks which had previously been either partially or wholly reduced to a peneplain. Subsequently an orogenic uplift took place, and the relatively weak beds were removed from the higher exposed ridges, and were preserved at lower less-exposed levels, where they now form strips occupying the floors of the main valleys and part of the flanks of the adjacent ridges, or form a fringe on the seaward side of the outer range of this mountain mass.

As the author of the paper referred to applies this explanation to the country to the south-east of the Kaikouras on the borders of North Canterbury, and suggests a similar origin for various important physical features of that district, the present paper has been written with the object of examining how far these principles may be applied to the country farther south, and what modifications, if any, must be made to frame a satisfactory explanation of those features. As most of the evidence bearing on the question will be furnished by an investigation of the conditions obtaining in the case of the intermontane basins of the province, a consideration of their features is a requisite before a proper conclusion on the point can be arrived at.

We find in various parts of the mountain region of Canterbury and its adjacent districts small outliers of sedimentaries of Cretaceous and Tertiary age, consisting of members of the following sequence, which in its complete form comprises the following, starting from the top:—

7. Calcareous gravels, sands, and shell-beds.
6. Sands more or less consolidated and passing downward into—
5. Grey Marl.
4. Limestone, glauconitic in its higher parts, and argillaceous in its lower; the lower member frequently absent.
3. Greensands.
2. Sands and clays, the former frequently sulphur-bearing, and with large numbers of rounded concretions containing saurian remains.
1. Clays and conglomerates with coal.

These rest everywhere in the Canterbury region on folded sedimentaries of Trias-Jura age or on volcanics which have penetrated and overlie these sedimentaries. It must be noted, however, that the sequence just quoted is rarely complete, and that, as is natural in a country which has been exposed to active erosion for a considerable period, it is the lower members which are most frequently in evidence. The number of remnants of these beds is somewhat large, and they are usually placed in basins either partially or wholly surrounded by the Trias-Jura rocks. The chief of these basins are the following: Hanmer Plains, Culverden Plain, Castle Hill basin, the Mid-Waimakariri, the Upper Rakaia, Lake Heron, Mid-Rangitata, Upper Pareora; but there are others of small size which have an important bearing on the problem.

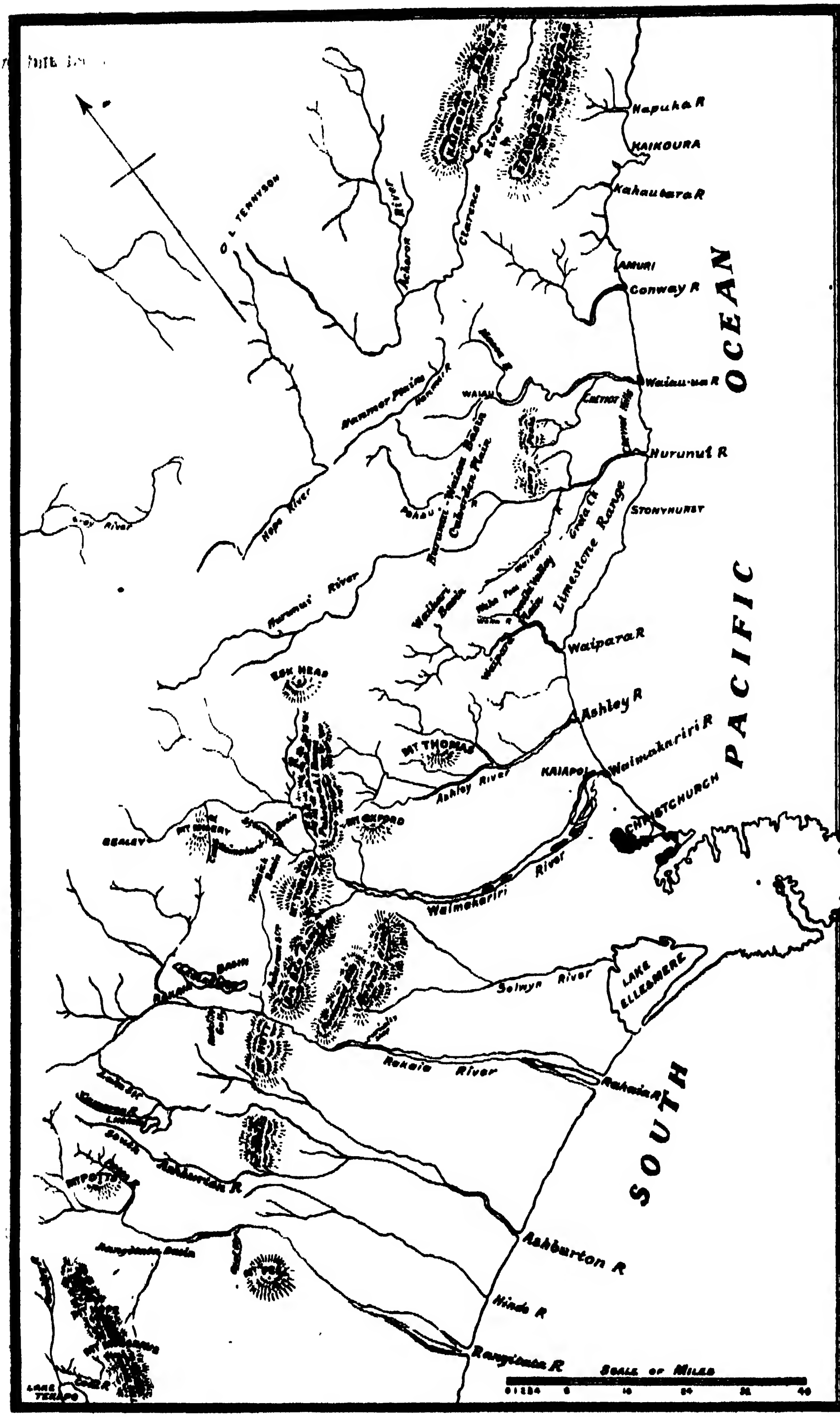
The two suggestions that have been put forward to explain their occurrence are,—

1. They are the remnants of a widely distributed cover of Tertiary beds which once masked the greater part of the surface of the country. Since they were weak structurally, they have been removed from the higher and more exposed parts of the country by ordinary erosive agents, such as frost and rain, but more especially by the abrasion of the great glaciers which in Pleistocene times filled the valleys. The isolated fragments of this covering are only to be found in positions where they were more or less shielded by the form of the ground from these erosive agents.

2. They have always been in the form of discontinuous deposits, and represent materials which have been laid down in isolated areas which were invaded by the sea, the basins having been eroded in pre-Tertiary times, and were, during the time of deposition, bays, gulfs, or straits belonging to a more open sea; and these basins had even at the time of deposition a form closely approximating to that which they have at present.

The first suggestion has found its strongest support up to the present from Cotton. There are suggestions, however, in the writings of others that the idea had occurred to them. Cox, for instance, in his "Report on the Geology of the Clent Hills District" ("Report of Geological Explorations," 1877, p. 107), notes the wide extent of the Cretaceo-tertiary series in that district, and concludes that they have not filled valleys of erosion owing to their presence at higher levels. Later, however, he departed from this opinion, for in his report on the same district in 1884 ("Report of Geological Explorations for the Year 1884," p. 43) he evidently regards the basins in which the Awamoa and Pareora beds were laid down as having much the same form as at present, for he considers the sea had access to the basin by way of the Rangitata River and the Pudding-stone Valley, and neither by way of the Rakaia nor by the Ashburton Gorge, which was not cut at that time.

Park apparently occupies a middle position, which results from his division of the Cretaceo-tertiary sequence of beds into two great series with an unconformity between them. This he places finally between the glauconitic limestone (Weka Pass stone) and the argillaceous limestone (Amuri limestone). He regards the series closed by the latter beds as his Amuri system, which was laid down in basins of previous formation, for he says ("Geology of New Zealand," p. 88), "The Cretaceous beds, although deeply involved in the faults that follow the foothills of the Inland Kaikouras, take no part in the tectonic arrangement of the rocks of the Hokonui system, but rest against them as marginal deposits that follow the strand


Hapuka R
KAIKOURA
Kahautara R
AMURI
Conway R
OCEAN
Waiau-ua R
Hurunui R
STONYHURST
Limestone Range
PACIFIC
Waipara R
Ashley R
Waimakariri R
KAIAPOI
CHRISTCHURCH
Clarence River
Acheron River
O. L. TENNYSON
Hanmer Plains
Hope River
Hurunui River
ESK HEAD
MT THOMAS
Ashley River
MT OXFORD
SEALEY
Waimakariri River
Selwyn River
LAKE ELLESMERE
Rakaia River
Rakaia R
SOUTH
Ashburton R
Ashburton R
Hinds R
Rangitata R
Rangitata Basin
SCALE OF MILES
LAKE TEKAPO

of the pre-Cretaceous sea, invading even the narrow tortuous fiords that stretched far back among the mountains of that date, as, for example, into the Trelissick basin and along the ancient rift-like Clarence Valley."

Again, on page 98, he says, "The marginal distribution of the rocks of the Karamea system; the manner in which they ramify into and around the narrow fiord-like valleys in Nelson and Otago; and the mantling sheet they form in western Nelson, gradually ascending from sea-level up to 4,000 ft. on the higher slopes of the main divide, seem to afford indubitable evidence that the main tectonic features of the country were already determined before the advent of the Cainozoic epoch." However, when referring to the folded limestones at Bob's Cove, Lake Wakatipu, he says (page 100), "Here we have a portion of a marine littoral involved in a great crust fold, and elevated to a height exceeding 5,000 ft. above the sea, affording clearest proof that a sea-floor existed in the early Miocene where the Richardson Mountains now stand."

Later, on page 144, he points out that marine conditions extended over a great portion of Central Otago, and that the block mountains were formed not by the subsidence of the portions of an elevated plateau, but by the uplift of the adjacent strips of territory.

It is apparent from these statements that Park certainly regarded Central Otago as a sea-bottom in Tertiary times, and that the marine deposits of Canterbury were laid down in arms of the sea, and were not the remnants of a widely extended overlying sheet.

McKay, in his report of the Trelissick basin (Geological Reports for 1879–80, p. 59) regards this basin as the result of movements accompanying the elevation of the surrounding mountains. Elsewhere in his reports McKay appears to consider that the Tertiary sequence of beds was more widely distributed, and that the remnants occurring in other places, such as in the Clarence Valley, were due to strips being preserved owing to their being let down along the lines of fault to levels where they were less exposed to eroding agents.

In connection with this, Hector states in his progress report for the years 1888–89, p. liv, "The evidence collected is, it must be admitted, strongly corroborative of the theory that the Cretaceo-tertiary and Amuri rocks once spread over the whole district, from the mountains on the north-west side of the Awatere Valley to the eastern seaboard, and have only disappeared from the higher elevations of the two intervening mountain ranges on account of the intense denudation that must have taken place, and is still taking place."

And in connection with the Trelissick basin, Hector remarks (Progress Report, 1885) that "the presence of fault lines in other parts of New Zealand is shown by structural movements that have isolated areas of Cretaceo-tertiary and Upper Tertiary strata, such, for instance, as the Trelissick area, which has been erroneously described as a basin."

Marshall gives no definite pronouncement as to the origin of these basins, but in his "Regional Geology," page 41, he insists on the presence of land of considerable extent, bold coast-line, and small rivers, while the glauconitic members of the middle of the Tertiary series were being laid down, with the sea in the area of deposition of approximately 200–300 fathoms deep. He notes, too, the extreme variability of the character of the deposits, the great thickness of conglomerate on the west coast of the island, the remarkable changes in the thickness of such beds as the Grey Marls, but concludes that the land-surface was depressed after long-

continued erosion. He makes no statement as regards the condition of deposition from which one could conclude that the land-surface was even approximately resembling that which exists now.

The strongest supporter of the theory that these beds were laid down in pre-Cretaceous-formed inlets is Captain Hutton, for he nowhere expresses any doubt as to their origin. The only exception to this statement is in connection with the Hanmer Plains, which he attributed to a local subsidence, and not due to the erosive action of glaciers (Geological Reports for 1874, p. 54). In the same report he accounted for the formation of the Hurunui Plains by the erosive action of the sea on beds which were relatively weak. He attributed at one time the basins at Wharekuri and at Castle Hill to erosion of glaciers, but he afterwards abandoned this idea. His most definite statements, however, are made in his paper on the "Origin of the New Zealand Fauna and Flora," which appeared in the *Annals and Magazine of Natural History*. He there maintains (page 91) that the erosion of our mountain valleys such as the Rakaia was more profound in pre-Cretaceous times that at present, and that the patches of Tertiary rocks were formed in them when they were inlets of the sea. Again (Trans. N.Z. Inst., 1886, p. 411), he attributes the formation of the Trelissick basin to a pre-Cretaceous river, not to glacier erosion, and suggested that the sea entered the basin not by way of the Rakaia and the Acheron River, but by the Waimakariri and Craigieburn.

In vol. 43 of the "Transactions of the New Zealand Institute" (1911) there is a paper by Henderson on "The Genesis of the Surface Forms and Present Drainage-systems of West Nelson," which has some bearing on the question, since the author refers therein to the whole mountain region of the South Island. The arguments are somewhat difficult to follow, since all the grounds on which the conclusions are based are not fully stated, but the author evidently regards the Cretaceous and Tertiary deposits of the restricted area which he describes as having been laid down in rift valleys. He says (page 312), "The land seems to have been above sea-level till Tertiary times, when depression permitted the inroads of the sea into rift valleys which had already been formed. Deposits accumulated in these rift valleys. . . . When these last [limestones] were formed the land-surface of what is now west Nelson was represented by a series of base-levelled islands; to the east what is now the long line of the alpine peneplain rose from the shallow sea. Elevation now took place."

According to this statement, Henderson evidently regarded the limestone as laid down in rift valleys, but that the land was gradually reduced to the peneplain form, and the absence of detrital sediments in the limestones was due to the low relief of the land. He further suggested that the elevation which succeeded the deposition was differential, that blocks were elevated unevenly, and that the pre-Tertiary lines of fault again became active.

The question of the origin of these intermontane basins is discussed very briefly by Kitson and Thiele in a contribution to the *Geographical Journal* of the year 1910, dealing with the origin of the Upper Waitaki basin. Their conclusions are thus stated:—

The past geological history of the lake region in general of the South Island is probably as follows:—

1. Middle Mesozoic alpine folding, accompanied by fracturing, probably of a radial character. Some faulting along these lines.

2. Pre-Cainozoic dissection; valleys formed principally along lines of fracture of fault. Some features of many of the existing valleys and basins impressed.

3. Early Cainozoic subsidence, with infilling of valleys; marine transgression, the sea invading some of the depressions.

4. Middle Cainozoic uplift started, continuing with minor fluctuations to the present time. Faulting, with probably some warping, during middle and late Cainozoic times. Many of the old lake basins modified.

5. Advance of glacier conditions in late Cainozoic; existing lake basins and valleys modified by erosion and deposition.

The final summary of the authors suggests that the Waitaki basin is due to pre-glacial erosion, faulting, with probably some warping, modified by glacial action.

After a careful consideration of the opinions of these authors thus expressed, one must come to the conclusion that they have regarded this basin as chiefly formed in early Tertiary times, and that the Tertiary deposits were laid down in arms of the sea which penetrated it at a later date.

Seeing that there has been this discrepancy of opinion, it has been considered advisable by the present author to consider the evidence now available which bears on the question, and to bring forward additional facts which may help to elucidate the matter.

In all probability the best course to pursue will be to take the case of several of these basins in turn, and point out their special features. As the most distinctive of these is the Castle Hill or Trelissick basin, it will be considered first, and then reference will be made to the other areas in turn that may be considered as likely to furnish facts of importance.

TRELISSICK OR CASTLE HILL BASIN.

This basin lies behind Mount Torlesse, between it and the more westerly Craigieburn Mountains, and is perhaps the most remarkable of all of the intermontane basins. It forms an enclosed roughly oval-shaped space of about five miles long by three broad, surrounded on all sides by mountains which reach a general height of between 6,000 ft. and 7,000 ft. It is only towards the north-east that this ring is at all broken; in that locality there is a low saddle, composed of Trias-Jura rocks, which separates it from the Craigieburn district and the adjoining Mid-Waimakariri basin.

The structure of the Trelissick basin has been dealt with by both Hutton and McKay, but unfortunately neither of these geologists examined all parts in detail, and there are several discrepancies between the descriptions of these observers and the actual facts. In general, it appears to me that McKay's account is the more correct of the two.

The general sequence of beds, in descending order, is as follows, according to Hutton, and is confirmed with slight modifications by the observations of McKay and of the present writer:—

Pareora—

- Blue shales (plant-beds).
- Soft grey sandstone.
- Grey sandy clays and shales.
- Lignite.
- Grey sandstone full of Lamellibranchs.
- Grey sandstone, current-bedded.

Oamaru—
- Limestone.
- Volcanic grit.
- Tufaceous greensands, calcareous tuff.

Waipara—
- Argillaceous limestone.
- Greensands.
- Grey Marl.
- White sandstone.
- Green sandstone with concretions.
- Sandstones, with *Ostrea* and *Conchothyra*.
- Sandstone with lignite.

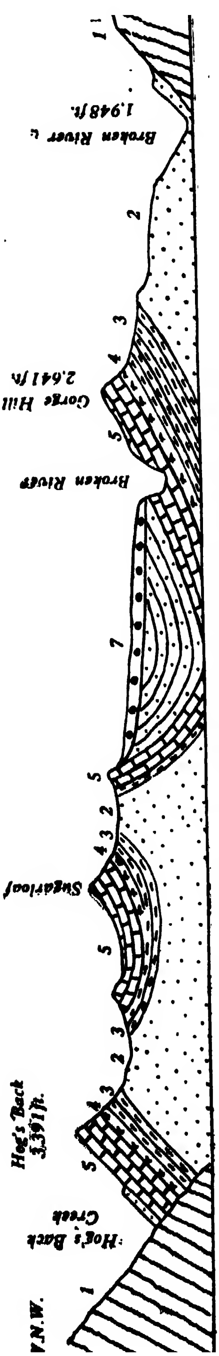
The approximate thickness of the Pareora beds is 500 ft., of the Oamaru beds 150 ft., and of the Waipara beds about 1,600 ft.

Unconformities have been put in various places by different authorities, but it appears to me that the beds are physically conformable throughout, the only dislocations being those attributable to volcanic action or to faulting or folding movements; in some places, however, obscurities occur, the elucidation of which may ultimately lead to a revision of this statement. I have specially in my mind the absence of the upper limestone over considerable areas. The general lithological nature of the beds indicates that the sea of the region gradually became deeper, the maximum being reached during the deposition of the limestones, after which shallowing succeeded, whether by uplift of the bottom or by aggradation has not been determined. This shallowing was followed by a slight deepening towards the close of the period of deposition, and when the land finally emerged at the close of this cycle of deposition it probably remained permanently above the sea.

The most striking feature of the beds is the absence of coarse sediments such as would occur were the conditions of the surrounding country, or even the height of the land relative to the basin, at all similar to those now existing. The actual presence of land is proved by the sandy beds and by the lignites, the last-named being also noteworthy as they occur at two distinct horizons. This shows that at least on two occasions shore-lines were near the area. A somewhat interesting constituent of the coal-bearing beds in the Craigieburn Gully (which is a small outlier of the basin across a low pass to the north-east) are rolled fragments of rhyolite. Now, no occurrence of rhyolite *in situ* has been found inside the basin or nearer than the Rakaia Gorge and the Malvern Hills. Between these localities and Craigieburn, which are nearly twenty miles apart, there lies a continuous ring of mountains rising at times to a height of 6,000 ft., and it seems impossible, as noted by Hutton, that these pebbles could be transferred under present conditions of relief. In confirmation of the movements of these pebbles I have recently been given a pebble of rhyolite of similar nature picked up in the bed of a small creek near the outlier of coal in the Acheron River in the Rakaia basin, which has been carried in some similar way. It could not have been carried under the present conditions. Hutton was fully aware of this difficulty, as may be seen from a reference to his report on the Trelissick basin.

Then, again, if we assume, with Hutton and others, that physical breaks occur, we should expect, were the relief the same as now existing, or if it resembled it to some degree even, that basal conglomerates and other relics of the existence of land should occur in some parts of the basin at the points

where discordance occurred. The limestones are of a resistant nature, and fragments of them should certainly appear in the overlying beds. Their absence furnishes either strong probability of the continuous deposition of sediments in the area or positive proof that the relief of the land relative to the basin was far different from that existing now. So that one at least of Hutton's hypotheses appears to be untenable.



SECTION FROM HOG'S BACK ALONG WATERFALL CREEK AND BROKEN RIVER, TRELISSICK BASIN.
1. Greywacke. 2. Greensands and coal. 3. Marls and sands. 4. Tuff. 5. Limestones. 6. Calcareous sands and shell-beds. 7. River-gravels.
Length of section, four miles (approx.).

The structural evidence is also somewhat important. There is definite proof that the rocks of the area have been subjected to decided folding movements, the general result being analogous to what would happen were a layer of plastic clay placed flat on the palm of the hand and the palm closed slightly. The harder and more resistant limestones show this admirably, faulting, both normal and reversed, the latter exhibiting decidedly flat fault surfaces, and overturned folds show the intensity of the lateral pressure. This is clearly seen on the western side of the area, between the upper part of Broken River and the Hog's Back Creek, but especially so in the country between the latter and Waterfall Creek. Where the limestone band crosses Broken River, about a mile above the ford on the road, it has been tilted till it stands almost vertically, and a portion has been displaced towards the centre of the basin relatively to the lower member, the plane of rupture being almost horizontal. Farther up the river the line of outcrop of the limestone takes the form of a letter S, and in the deep, narrow, precipitous gorge of Waterfall Creek there are several small faults at points where the strain was probably the greatest when the folding took place. In the Hog's Back Creek the limestone is slightly overturned, but on following the outcrop north the dip slowly diminishes till it becomes a moderate one to the west when the Waterfall Creek is reached (see accompanying section). It must be noted that the interpretation of the structure, advanced by Hutton on hearsay evidence as to the locality, is not borne out on a closer examination on the spot. Farther south in the basin, in the upper portion of Whitewater Creek, there is a detached mass of limestone, dipping to the west, whose presence can only be explained by supposing that a fault has been run along the western

margin of the area, in close proximity to the Trias-Jura rocks, and isolated this remnant from the main mass of limestone which forms the crest of Castle Hill. This line of fault can be traced up Coleridge Creek to the extreme south-west corner of the area, as is evidenced by the blocks of limestone with westerly dip left in isolated positions high up on the western side of the valley of this stream. The straight alignment of its walls is strongly suggestive of glacier action, but there is no doubt its original form was determined largely by the fault-line.

The centre of the basin is masked by an overburden of Recent shingle and other river deposit, and on the eastern side the dip of the beds is inwards as a general rule, but in one or two cases, as at the gorge of the Porter River, it is almost vertical; on the whole, however, the folding is less pronounced on the eastern margin of the basin than on the west.

Farther east, in the lower part of the Broken River Valley, are outliers of the coal-measures belonging to the lower part of the Tertiary or the Upper Cretaceous series, as is clear from the presence of *Conchothyra* and other fossil molluscs. These have evidently been folded on axes running in a general north-and-south direction, and the surface on which they were laid down shows evidence of considerable warping. The coal-measures usually occupy the lower levels of deep valleys, where they have been protected from denuding agents. There is some evidence of faulting, and in one case at least, in the bed of Sloven's Creek, the Trias-Jura rocks have been bodily pushed over the Tertiaries from the eastward. It is extremely probable that both of the parallel valleys of Sloven's and Winding Creek have been determined by faulting. In one or two places there occur, intercalated in the greensands which overlie the coal, irregular beds of angular greywacke pebbles up to 3 in. in diameter which cannot have travelled far from some exposed rock-surface; but, judging from the lie of the coal-beds, the surface did not resemble that which now exists.

The remaining portion of the Waimakariri basin, with whose features I am not at present as well acquainted as I should like, is no doubt of similar origin to the Castle Hill area. Fragments of coal-measures are found in various portions of it, and there is a great mass of limestone in the valley of the Esk River near Mount White, and, judging from its presence, as well as that of occasional small remnants of sedimentaries similar in character to the Pareora beds of the Broken River basin, it seems clear that these Tertiaries once covered the floor of this Waimakariri basin more or less completely, but have been removed almost entirely by erosive agents which were especially active in that locality in Pleistocene times and later. The Esk River limestone owes its preservation to being out of the sphere which was especially subject to glaciation, since there are everywhere signs that the intensity of ice-action fell off on the eastern side of the great mountain valleys, especially where their heads do not reach as far back as the main divide, but belong rather to the drier mountain region to the east. The boundary of this area on the eastern side is the great ridge of the Puketeraki Mountains, whose steep western faces and even alignment suggest an origin dependent on some great structural feature such as faulting. This would be quite in keeping with the features exhibited by other basins, where the eastern margin is determined by fault-lines while their western side exhibits folding.

The general results of this statement of the conditions governing the formation of the Broken River and its associated basins are,—

(1.) That land existed in the neighbourhood of the area at the beginning of the period of deposition, and that it also existed subsequently, although on some occasions the sea grew deeper.

(2.) That the land did not supply coarse sediments, and probably was of low relief.

(3.) That it was different in form from that now existing.

(4.) That the rocks of the basin have been subjected to faulting and folding.

(5.) That the Tertiary sediments are the remains of a once much more widely extended sheet.

(6.) That the general character of the beds and their structural features are those which might arise if the beds had been laid down on an old peneplain or plain of marine denudation, and that certain areas had been subject to either faulting or folding movements which depressed them below the level of this old surface, and that when elevation of the land took place these deposits occupied the basins of relatively less height far below the general level of the mountains.

(7.) This surface has been dissected by stream and glacier action as well as by other denuding agents, and the relatively weaker beds have only been preserved where the form of the ground sheltered them from these destructive agencies.

RAKAIA VALLEY.

In the main Rakaia Valley there are five outliers of the Tertiary beds if we neglect those in the valley of the Cameron River and near Lake Heron, which belong more properly to the Upper Ashburton and Rangitata occurrences. The former include coal-measures at the Acheron River, at Mount Algidus, at the Rakaia Gorge, all of which are now without limestone. These and the overlying sandy beds with shell-remains, similar to those in the Trelissick basin, are, however, preserved at Redcliff Gully, where, owing to their position, they have been out of the line of action of the ice-stream which once operated in the Rakaia Valley. Similar beds are also exposed at the Curiosity Shop, where the river has cut through the gravel of the plains about three miles below the gorge itself. These isolated fragments, occurring as they do in widely separated parts of that valley, are probably remnants of a sheet which once occupied it completely. They do not, however, furnish much evidence as to the circumstances of their deposition, the lower exposed members of the series being sands or clays, with the exception that at the Rakaia Gorge there are fairly coarse conglomerates, composed chiefly of fragments of rhyolite, similar to that which lies underneath the Tertiary series and forms the volcanoes of the Rockwood Hills and their various extensions. In the Redcliff Gully the beds have been subjected to faulting and folding of an intensity similar to that in the Trelissick basin. The limestone also has been elevated, till it now exists at a height of 3,700 ft. above the sea.

ASHBURTON-RANGITATA REGION.

There are in this district two areas which may be designated intermontane basins. These are the Lake Heron Valley, which extends from the vicinity of Lake Heron across the middle course of the South Ashburton River, and is bounded on the north-west by the high country stretching from Mount Arrowsmith, and on the south-east by the range which extends from the Rakaia River towards the Ashburton, and includes the following

elevations: Mount Hutt, Mount Alford, Taylor Peak, Mount Somers, and the Clent Hills. This valley has connection with the Rangitata area by means of the Pudding-stone Valley and by the wide valley extending from Hakatere towards the Potts River.

The basin of the Rangitata includes the Mesopotamia country, and extends down the river to about eight miles above the Mount Peel Station. Both these basins are in all probability of structural origin, but have been modified extensively by glaciation. They contain numerous remnants of the Tertiary series, which, as originally pointed out by Cox, has no relation to the present form of the country. They are almost entirely of sands and clays with coal-seams, and only near Lake Heron and at Coal Creek, on the south bank of the Rangitata, are any covering limestones present. The former limestones were classified as Miocene by Cox, and put in the Oamaru formation by Haast, and the latter, judging from its fossils, is of the same age as the Mount Brown limestone of North Canterbury, which may be correlated with the Mount Somers limestone. They are, therefore, in all probability of later date that the Malvern beds, and represent the gradual extension of the coal conditions over central and southern Canterbury. Remnants of the coal-measures are now found in the Cameron Valley; near Lake Heron; in the valley of the Smite Creek; near Clent Hills Station; in the valley of the Potts River. The last-mentioned outlier occurs at an elevation of about 3,000 ft. to the north of the ice-swept and moraine-covered downs which stretch from Mount Potts in a south-easterly direction towards the river of the same name. The total length of the exposure is about 25 chains, with a maximum breadth of about 7 chains. The beds consist of sands and clays about 200 ft. in thickness, with several seams of brown coal, one of which is 18 ft. thick. They have a general strike in a north-west to south-west direction, with a dip to the south-west at an angle of about 60°; in some places this is a little flatter, but the variation may be due to slip. There is no capping of limestone present, nor was I able to discover any fossils, but from the general circumstances it is evident that the coal belongs to the same series as that at Mount Somers. The beds owe their preservation to having been faulted down and brought into such a position that they have not been subjected to the full intensity of the glacial erosion which other parts of the same valleys have experienced. A similar occurrence exists in the valley of a tributary of the Godley River, in the Mackenzie Country basin, which lies just across the Two Thumb Range, the dividing ridge between the Rangitata and Waitaki basins. In the country immediately to the west of the Lake Stream coal-measures are found up to levels of between 4,000 ft. and 5,000 ft., and these fragmentary occurrences are evidently the remains of a once widely extended sheet. As a rule they do not show much signs of dislocation, though there is no doubt that their position points to certain of them having been faulted down, and their persistence may be due to their having been thus removed from the operation of active erosive agents. Their frequent distribution at high levels, associated with occurrences at lower levels, is strong evidence that the sheet was extended over a surface unlike that now existing, and that the surface has been subject to serious dislocations. The evidence from this locality is strongly in favour of the wide distribution of a mantle of Tertiary beds, and is remarkably analogous to the conditions obtaining in Central Otago, where the quartz drifts and associated beds of Tertiary age are found at times depressed in hollows and again in close proximity acting as a capping to the flat-topped schist ridges.

WAIAU-HURUNUI BASIN.

This basin lies across the middle courses of the Waiau and Hurunui Rivers, and is perhaps the most typical of all those within the Canterbury area. The rivers have cut deep gorges through the barrier which bounds it on the east, and furnish a most interesting example of anomalous drainage. Cotton has suggested that the rivers were antecedent to the present land-surface, and that the gorges were cut as the surface was warped upwards. The other explanation, which was originally advanced by Hutton, is that it is a case of superimposed drainage.

The basin through which these rivers run extends for nearly thirty miles in a south-west to north-east direction, and has a maximum breadth of about eight miles, its elevation above the sea lying between 500 ft. and 800 ft. The greater part of its surface is formed by the combined aggraded flood-plains of the Waiau, Pahau, and Hurunui Rivers, but at one or two places the Tertiary beds rise through this covering. An extension of this basin lies on the south side of the Hurunui River, and reaches the Waipara River in the neighbourhood of Heathstock, with outlying portions in the Upper Okuku and Ashley Rivers; and another connection with it lies toward the upper head of the Waikari Creek, the dividing ridge being quite low, and constructed entirely of Tertiary rocks.

The general sequence of beds exposed in the area is as follows :—

(1.) Sands and clays, with beds of greywacke, gravel, and very occasionally impure coal. These are well exposed in the banks of the Pahau, on the western side of the basin, in the valley of the Mason River to the north-east, and in the deep gorges cut by the various tributaries of the Waipara River near Heathstock.

(2.) Limestones, frequently interstratified with volcanic tuffs. These are typically developed on the north-west side of the area between the Pahau and Waiau Rivers in the valley of the Mason, and near Heathstock. In the central portion, on the south-east flanks of Mount Culverden, they dip steadily to the south-east at angles of about 15°; farther west they have been folded into an anticline, and in the lower part of the gorge of the Pahau River the dip is to the north-west, but the directions are much disturbed by volcanic action. The limestone outcrop can be traced round the north side of the basin, across the Hurunui, and on the flanks of Mount Mason, but the outcrop is not continuously visible. In this last-mentioned locality the limestone is folded back sharply where it abuts against the Trias-Jura rocks of Mount Mason, although the general dip appears to be towards the south-east. On the south side of the basin, along the Hurunui River, the limestone has evidently been faulted down and covered up by gravels, but farther west it reappears, the fault grading into a fold, and the outcrop follows round the western end of the Trias-Jura mass forming the Mount Alexander Range and joins on to the Weka Pass stone near Waikari, which, when followed north-east down the Waikari Creek, forms one of the strips of limestone in the floor and on the north-west flanks of fault valleys which are so characteristic of this region of Canterbury. This fault also grades into a fold in the upper part of the Waikari Creek basin. There is a marked difference, however, in the fossil-content of the limestones in the Culverden area from those of the Weka Pass stone, for the former seem to accord more closely with those of the Mount Brown beds, which lie above the Weka Pass stone, a fact which is probably explained by the gradual and slow transgression of the sea over the Culverden area

towards the north-west, the limestone, although continuously linked up with the Weka Pass stone, being deposited synchronously with the Mount Brown stone.

(3.) The limestones are followed by sands and gravel beds with bands of conglomerate composed almost entirely of greywacke. These are well developed in the Isolated Hills, where the stratification is much disturbed. They occur with regular dip to the south-east at Mouse Point, near Culverden, accordant with that of the underlying limestones; but they are folded into a well-marked anticline at Hurunui Mound; and they form low hills on the south side of the Hurunui, which extend towards the Waipara River along the eastern side of Mason Flat, and divide that part of the basin from the upper part of the Waikari Valley. These beds overlie the limestones conformably on the western end of the Alexander Range. On following the line of outcrop west past Hawarden and Horsley Downs, the dip becomes very steep to the west till on reaching the Doctor's Range of Trias-Jura rocks the dip is nearly vertical. This part of the basin appears to be formed of beds arranged as a syncline, with the eastern limb much more highly inclined than the western, a feature which appears to be almost invariably exemplified, for the eastern edge of these basins is determined by lines of faulting grading into steep folds. Similar arrangements of the beds occur in the Omihi Valley, in the Lower Waipara, which has its south-eastern margin bounded by a fault, but it is not seen in the Cheviot basin, which lies between the Waiau-Hurunui basin and the sea, being divided from the former by a range of older rocks and from the latter by a similar range, but the limestones pass right over this range without any marked signs of faulting or break. The arrangement of the beds in the Cheviot basin is synclinal, but as the Tertiary strata are followed south-west they exhibit faulting which accounts for the characteristic strip of let-down Tertiaries which occupy the valley of the Greta Creek.

The lithological and faunal evidence indicates clearly that land existed in the neighbourhood of this area at the beginning of the cycle of deposition; that the sea gradually extended over the area, followed by the shallowing of the sea and the deposition of littoral beds. These have been subjected to folding movements in which the underlying Trias-Jura beds are involved, so that the form of the land-surface on which the Tertiaries are laid down is quite different from that which now exists, but there is distinct evidence of the close proximity of land throughout the period of deposition. There is no sign, however, of any erosion of the underlying beds while the later ones were being deposited, judging from the absence of pebbles of limestone in the later deposits, so that it is unlikely that the movements to which the rocks have been subjected had commenced during the latter part of the period of deposition. Owing to erosion of the relatively weaker Tertiary beds, a large area of these rocks has been removed; but it is extremely unlikely that they extended over the whole area. Isolated peaks of Trias-Jura rocks no doubt existed as islands in this sea, but they were by no means as extensive as the present areas of mountains composed of these rocks. The basins have no doubt had an origin in deformational movements either of folding or faulting, both of these movements being closely related to each other.

Hanmer Plains.

This inland basin has generally been regarded as of structural origin, even Hutton admitting this as being extremely probable. That earth-

movements have taken place in its vicinity is evidenced by the fault fissures of recent earthquakes, and by the peculiar strip of folded-in limestone which crosses the Waiau River at Marble Point, just below where the river issues from the basin.

CANTERBURY PLAINS.

There is a marked resemblance in general features between the aggraded flood-plain of the Hurunui basin and the Canterbury Plains, which perhaps may be regarded as a large intermontane basin, with the mountain barrier absent on the eastern side. There is some evidence that the plains have been formed by the deposit of gravel on a syncline of Tertiary rocks.

I have noted in the appendix to my paper, "Some Aspects of the Terrace-development in the Valleys of the Canterbury Rivers" (Trans. N.Z. Inst., vol. 40, 1908, p. 40), that there is a probable outcrop of coal-measures beneath the sea of the Canterbury coast, indicated by the frequent appearance in the trawl of the steam-trawler "Nora Niven" of large pieces of lignite or brown coal. These were obtained in depths of between 21 and 43 fathoms on a line following the coast-line and about twenty-five miles distant from it. Beyond the line where these were picked up the sea-bottom rapidly deepens, and it is probable that they have been torn from the edge of a submerged escarpment of Tertiary rocks where the coal will be in position. There is also on Banks Peninsula an outcrop of Trias-Jura rock, similar to that of the Malvern Hills, with overlying rhyolites of identical lithological composition. This, too, is overlaid, at the head of Lyttelton Harbour, at Quail Island, and at Governor's Bay by quartzose sands, whose age cannot be exactly determined owing to the absence of fossils, but it is perfectly possible that they represent similar sands associated with coal-measures on the western side of the plains. The shales with plant-remains occurring near Gebbie's Pass probably date from the same period.

A most persistent feature of the Tertiary deposits referred to above is the occurence at their base of a fairly fine conglomerate composed usually of pebbles of the underlying Trias-Jura greywackes. At Mount Somers, Rakaia Gorge, Malvern Hills, and in the Trelissick area rolled fragments of rhyolite of a kind which now forms mountains on the eastern front of the Alps from the Selwyn to the Ashburton River is a notable constituent of this conglomerate. The presence of these rolled fragments shows clearly that the existent masses of rhyolite in close proximity to these sedimentaries were a land-surface of considerable extent at the time when the coal-measures of Canterbury were laid down.

On the western slopes of the Alps the basal beds of the coal-measures contain an enormous thickness of coarse conglomerates, approximately 2,000 ft. (*vide* Bulletin No. 13, N.Z. Geol. Survey, p. 51). In this publication Morgan says, "Apparently the highlands supported glaciers, for somewhat outside the subdivision rocks corresponding to the basal conglomerates show glacial characters." He also points out that the land which furnished these boulders lay probably to the north or north-west; that there was then no Grey Valley, no Paparoa Range, and possibly no Southern Alps. As mentioned later, such a land may have formed the sanctuary where the Antarctic and Subantarctic elements in our flora found a refuge, at a time when the site of the present Alps was occupied by land of relatively low elevation.

It is to be noted besides, in places where the conglomerates do not occur, that sandstone beds at the base of the series are coarse in texture, and are

indicative of the proximity of land. The presence of coal points to estuarine conditions, and to the existence of a neighbouring land-surface, whether the coal be formed from plants growing *in situ* or from drift material.

The beds succeeding the coal afford evidence of a gradual deepening of the sea, in which sand, greensand, and limestones were progressively laid down; but shore-line conditions must have obtained even then, for the limestone almost invariably thins out or disappears or is replaced by sandy beds as it is followed towards the old land-surface formed of Trias-Jura rocks.

It has also been noted by Hutton that at Stonyhurst a bed of conglomerate formed of subangular pebbles of slate lies between the Amuri limestone and the Weka Pass stone, thus showing that the shore-line was fairly close even at the time that the limestones were deposited in this area (Quart. Journ. Geol. Soc., vol. 41, 1885, p. 271).

It must be admitted, however, that the evidence of the presence of a shore-line is not apparent in all localities where the Tertiary sediments occur, but it is probable that the littoral deposits into which the limestone must gradually pass as it is followed landwards have been removed by denudation. The long strips in which this now occurs have been tilted by earth-movements, and now frequently occupy the floor and north-westerly flanks of the valleys, and the part which abuts against the more resistant Trias-Jura rocks has been necessarily more exposed to erosive agents working along the line of junction of the rocks, especially as the lower members of the overlying series consist of somewhat incoherent sands. There is a distinct suggestion of the former higher extension of these covering beds up the flanks of the mountains in the appearance of the landscape immediately above the present limits of the Tertiary beds, the most striking form being long valleys cut approximately parallel to the line of strike of the Tertiary beds by old subsequent streams operating along the line of junction of the two series, and for a part of their course incising the harder rock underneath. The character of the soil indicates that the limestones and associated beds once had a much farther upward extension than they now have.

A striking illustration of this is found in the valley of the Pareora River, about ten miles from Timaru. Here the Tertiary beds are found passing over the hills of Trias-Jura rock, arching with the rise of the ground and completely capping the tops in some cases, as at Craigmore, without any break in continuity owing to erosion; while farther north the uncovered greywackes project through the Tertiaries. This case is most interesting, as it shows that warping movements have taken place since the Tertiaries were laid down in that locality, and thus renders it probable that similar movements have taken place elsewhere within the Canterbury District, and increases the probability of the wider extension of these beds than exists at present.

After the deposit of the limestones the sea shallowed either by aggradation or by elevation of the bottom, for marls, sands, and coarse rubbly beds with fragments of shells, succeeded by incoherent sandy and marly beds with a littoral fauna, are widespread in Canterbury. It has been pointed out as well that in the Trelissick basin coal-beds occur among the upper members of the series, with marine beds lying on top, showing that the sea advanced over the area once more. It seems, therefore, perfectly clear that the deposits were laid down in the vicinity of a shore-line, but in

all probability the land was of slight relief, or that the waters were sheltered from violent currents and waves.

However, in considering the question of the relief of the land as deduced from the character of the deposit, allowance must be made for the situation of the locality of deposition. Even on elevated coast-lines pebble beaches are frequently absent for long stretches, and therefore it is perhaps inadvisable to be dogmatic on this point.

It is found, however, that conglomerates form an increasingly important feature of the beds succeeding the limestones, and towards the end of the Tertiary era they dominate the sedimentaries. This is clearly seen in those places where the Pliocene beds are well developed, such as in the lower Waipara and Teviotdale districts and in the Mount Grey downs. The abundance of coarse gravels indicates the existence of higher land in the vicinity, but the strata containing them appear to be perfectly conformable with the older beds of the Tertiary sequence. This increasing content of Trias-Jura pebbles apparently indicates a rise of the land, but there is no certain evidence of any structural unconformity between these beds and the lower members of the Tertiary sequence. If the rise of the land had occurred this should be forthcoming, certainly as regards shore deposits, although it might be absent in the case of beds laid down in deep water offshore. Some slight variation in the conditions controlling the land-surface, rather than a great modification in the relief, would explain the increasing importance of the coarser materials.

After a careful consideration of the evidence, it seems fairly certain that a land, probably in the form of islands, did persist in the North Canterbury area throughout Tertiary times, although it is quite possible that a deep sea existed on the site of the Kaikouras, and that the deformations which resulted in the formation of those great ridges were less pronounced in the country to their south-west, and probably petered out in the mid-district of Canterbury.

There is another point which may be considered in this connection. Micaceous sandstones are a frequent occurrence in the Tertiary beds of North Canterbury, and the source of this mineral must be looked for elsewhere than in the Trias-Jura rocks to the westward. Although a small amount of this mineral occurs in these rocks as a detrital constituent, it does not seem sufficient to account for the large amount contained in the derived Tertiaries. Although it is a long way to the Chathams from the coast of Canterbury, yet mica and other schists do occur in those islands, and there may have been at one time a closer connection with similar rocks occurring in New Zealand, and the existence of a submerged schist area which might have furnished this material is by no means a remote possibility. If, however, we must look to the granite and schist areas on the west of the main divide to have furnished this material, then the form of the land-surface must have been entirely different from that which now obtains.

The presence of a land connection with the Chatham Islands in Tertiary is absolutely necessary in order to explain the close resemblance of the fauna and flora of these islands to that of New Zealand. Hutton suggested that the land bridge was in existence in Pliocene times, though it broke up soon after, this break being indicated by the fact that some of the Chatham Island species do show a considerable variation from their New Zealand relatives; and, further, there are species occurring in those islands which have not been discovered on the main islands. He therefore considered that the land connection was broken before the Pleistocene period began.

This connection he attributed to an elevation of the sea-bottom synchronous with an elevation of New Zealand itself, which he postulated in order to explain the extension of the glaciers. It is reasonable to think that in mid-Tertiary times the Chathams were covered by the sea, from the occurrence of a limestone similar to that of New Zealand with a similar fossil fauna. The form of the land-surface of these islands suggests that subsequently they were base-levelled either by the sea or by subaerial agencies.

Again, Cockayne, in his paper on the "Plant Covering of the Chatham Islands" (Trans. N.Z. Inst., vol. 34, 1902, p. 316, footnote), says, "The occurrence on Chatham Island of *Coprosma chathamica*, so closely related to *C. petiolata* of the Kermadecs, and of *Rhopalostylis baueri* in both regions, if the identification of the latter be correct, suggests that they travelled along the coast, which would, in the event of an east and north-east extension of New Zealand, join the Kermadecs and the Chathams." There is good reason, however, to doubt the occurrence of *R. baueri* in the Chathams. In the same paper (p. 314, footnote) the author notes the occurrence of *Suttonia chathamica* at Stewart Island, a plant formerly believed to be restricted to Chatham Island; but in his report of the botany of Stewart Island the author is very guarded about this occurrence, and considers the possibility of the plant having been introduced by the Maoris, although he thinks this extremely unlikely. If this last contingency is excluded, the Kermadec-Chatham Island coast-line might be prolonged to Stewart Island, following the line of the submarine continental shelf; but it appears somewhat dangerous to base such a conclusion on the evidence from one or two occurrences of plants unless supported by other lines of evidence.

The presence of a land in Mesozoic times is rendered probable by the persistent appearance of granitoid and other rocks as boulders in strata of Jurassic age, and later, there being no known occurrence *in situ* in close proximity to these deposits which could have furnished these boulders. These deposits occur near Gisborne, in beds which are, according to McKay, of Lower Tertiary or Cretaceous age, but, according to Adams, of Upper Miocene age. They occur in Mesozoic strata near Cape Palliser; at Cheviot; in the valley of the Acheron and Rakaia Rivers; in the Pudding-stone Valley on the north side of the Rangitata; in the Malvern Hills; and in various parts of Otago; and it is probable that they have been shed from a land stretching east which persisted down to Tertiary times. If Adams's determination of the age of the Gisborne deposits is correct, then such a land most probably existed down to the middle of the Cainozoic era, for, as far as is known, the rock pebbles of these beds are not likely to have come from the Trias-Jura ranges to the west.

The origin of the native flora of the country must be considered fully before coming to any conclusion as to the relief of the land. It seems impossible for the Antarctic element to have established itself or to have maintained itself in competition with the Malayan element had the high land been completely removed during any part of the Tertiary era, unless there had been adjacent tracts of elevated country, now completely submerged, to which it might have moved as to a sanctuary; but the difficulty in the way of an invader obtaining a footing seems so great that it appears more likely that an area once peopled has not been subject to great modifications since the colonists obtained a footing. Migrations due to climatic change, or to changes due to the changed elevation of the land, no doubt occur, but very slowly. It seems clear, therefore, that high land must have existed continuously over parts of the South Island, or close to it, since the Antarctic

element in the flora appeared, but that the form of the land-surface was entirely different from that existing now. The Southern Alps did not exhibit their present form. Indeed, it seems reasonable that after the first formation as a folded range, at the close of the Jurassic or the beginning of the Cretaceous period, they were reduced to a peneplain—this would take place towards the close of the Cretaceous period—and that on this peneplain the Tertiary beds were laid down; that subsequently they experienced vertical and perhaps differential uplift, with a certain amount of folding and undoubted faulting; and that the Tertiary sediments which now exist as discontinuous remnants in the intermontane basins are survivals of this covering sheet. It is not maintained that they formed a complete veneer over the whole surface, but that elevations that survived the period of erosion projected like islands through the Tertiary sea, and may in some cases have been sufficiently high to form sanctuaries for the Antarctic element in our flora.

ART. XXXVII.—*Recent Changes in the Position of the Terminal Face of the Franz Josef Glacier.*

By R. SPEIGHT, M.A., M.Sc., F.G.S.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1914.*]

THESE notes as to the position of the terminal face of the Franz Josef Glacier are based on observations supplied to me by Mr. Alec Graham, one of the guides of our alpine region, who resides in the immediate vicinity of the glacier, and to him my sincere thanks are due.

In the year 1909 the officers of the Geological Survey, under the direction of Dr. Bell, made a complete map of the Franz Josef Glacier, and placed pegs in position so that the changes of the face could be regularly and accurately determined. The pegs are numbered in order from the western side of the glacier, and the relative movements of the ice at each since they were put in position are given in the following list, the original situation of each peg being given first for the sake of reference:—

No. 1.—On the steep rock-face on the western side of the front, at approximately 7 ft. above the ice and 3 ft. from it. This peg was placed near the edge of the ice, but was afterwards covered, and now lies buried under the moraine left by the glacier. Since it was put in, the river has cut a huge gap, between the western wall and the ice, for about 24 chains, with a width varying from 2 to 3 chains. The nearest ice across the river is about 180 ft. distant.

No. 2.—On Harper Rock, 29 ft. from the ice-face and about 7 ft. above the river-bank. This peg is now 215 ft. from the face, so that the ice has receded 186 ft.

No. 3.—On Harper Rock, in a ridge about 10 ft. above the lowest part of the ice, but overhung by the cliffs and ice above. In 1912 this was 50 ft. from the ice, and now it is 120 ft.

No. 4.—In the ice angle of Park Rock, surrounded by ice excepting to the northward, but distant 69 ft. on the east and 75 ft. south. In 1912 it was 80 ft. from the ice, and is now 189 ft.

No. 5.—Thirteen feet above the ice, and 7 ft. from it at the inner edge of Strauchon Rock. In 1912 it was 270 ft. from the ice, and now is 350 ft. distant.

No. 6.—On Barron Rock, on a sharp ridge 17 ft. from the ice, and about 10 ft. above it. In 1912 it was 260 ft. from the ice, and is now 320 ft. away.

No. 7.—At 9 ft. above the ice, and at 7 ft. from it in the eastern rock border of the glacier. This peg stands on the top of a rock-face about 200 ft. above the face of the glacier (aneroid measurement). The ice has receded up the valley from this peg about 80 ft., whereas in 1912 it was only 45 ft. back from it.

These records show clearly that the glacier has retreated since 1909 an average of about 170 ft. across the face, and that there is a considerable shrinkage in the volume of the ice. The result is the more marked since the observation made by the Survey were at a time when the face showed signs of an extraordinary advance. There are distinct signs that another wave of movement will take place in a few years' time, for two miles up the glacier, at Cape Defiance, it has risen 20 ft. during the past year. In order to determine this movement more exactly, a mark has been placed by Mr. Graham about 50 ft. above the ice; this will enable future observers to obtain reliable data for the movements.

Marks are also being placed on the ice in order to determine the rate of movement. Bell arrived at an average maximum movement near the face of only 2 ft. per day. This was the result of observations extending over a continuous period of 134 days. Recent observations made by Graham on a boulder carried by the ice showed a rate of about 3 ft. per day.

Although no accurate observations have been made on the Fox Glacier, which lies in a parallel valley about twenty miles to the south of the Franz Josef, the conditions appear to be very much the same. There has been a recent marked retreat of the terminal face, and farther up the glacier there are signs of a pulse coming down similar to that in the Franz Josef Valley.

More accurate observations should be taken in order to determine the period of these waves of high and low ice, and to see if they accord with periods of change in the present climatic conditions of the country.

ART. XXXVIII.—*Note on the Occurrence of Petroleum in New Zealand.*

By R. SPEIGHT, M.A., M.Sc., F.G.S.

[*Read before the Philosophical Institute of Canterbury, 2nd December, 1914.*]

THE question of the origin of the petroleum known to occur in New Zealand has a scientific interest apart from its economic importance, but, unfortunately, the first is almost entirely dependent on the results which are furnished by attempts to prove the capacity of the fields commercially, and therefore, till a mass of evidence has accumulated as the result of boring operations, conclusions as to its origin must be largely of a tentative nature

In the following parts of New Zealand indications of the presence of petroleum certainly exist: (1) Taranaki; (2) Gisborne and the East Coast in the neighbourhood of Poverty Bay; (3) east coast of Wellington, between the Tararua Ranges and the sea; (4) in the valley of the Grey River, especially near Kotuku.

There are, in addition, other places of minor importance, such as the Clarence Valley and Cheviot, which have given indications of less positive nature. It must be clearly understood that, except, perhaps, in the first of the above-mentioned districts, the present prospects of the oil industry are doubtful; but the difficulties may eventually be obviated, and the actual result may prove more satisfactory than the present state of affairs perhaps indicates. Some of the difficulties are no doubt connected with drilling rather than the absence of oil in commercial quantities.

In all the districts cited the prevailing beds associated with the occurrence of oil consist of marine mudstones, marls, sands more or less coherent, with shell beds, all of Miocene or Mio-Pliocene age. The predominating strata are, however, mudstones and marls, locally known as "papa," and it is only where these exist in great thickness or continuity that the indications are strong.

The most important problem to be considered is whether these beds are the actual place of origin of the petroleum, or whether it is derived from a more deep-seated source and has migrated to the overlying beds along various lines of weakness or dislocation. A correct answer to this question would prove of the highest value in framing estimates for the adequate exploration of the petroleum-bearing areas. I therefore give the following brief summary of the position in accordance with the evidence now available; and it will be more convenient to refer first to the Taranaki area, since it is the best known and, according to present evidence, the most promising.

The strata which cover the greater part of the Province of Taranaki consist of the typical Miocene rocks of the North Island—viz., mudstones, sandstones, shell beds, and occasional bands of conglomerate which dip west and south-west at low angles in the neighbourhood of New Plymouth, but when followed towards the lower course of the Waitotara River change their direction of dip to the south-east, the line of strike turning approximately through a right angle. The thickness of these beds certainly exceeds 4,000 ft., as is disclosed by the bores at New Plymouth, and may be much greater, and they are apparently little disturbed by dislocations or other

deformations; but owing to the infrequency of good sections this statement is subject to revision; in one or two places undoubted faults of small throw are existent. Rising through these sediments and covering them over considerable areas are the volcanics from Mount Egmont and numerous small parasitic cones round the base of the mountain, as well as the igneous masses of the Kaitaki and Pouakai Ranges. The age of these mountains must be considerably greater than the cone of Egmont, but there is no strong evidence that they are of pre-Miocene age, although that is extremely probable. A notable constituent of the sandstone beds interstratified with the mudstones and marls of this age are fragments of hornblende crystals similar to the mineral occurring in the Taranaki volcanics. These would seem to indicate that a considerable area of igneous rocks was existent in the neighbourhood while the petroleum-bearing beds were being laid down. This fact may have some bearing on the date of the intrusive rocks at Moturoa, but, owing to the obscuring of the contacts between these and the intruded rock by the overburden of fragmentary volcanic matter, no conclusion can be come to at present; all the same, it is remarkable that bores could have been put down to 4,000 ft. within but a short distance of these masses. It seems, therefore, reasonable to suppose that they were intrusive into the Miocene rocks as well as into the pre-existing masses.

The interstratification of sand with close impervious beds of mudstone and marl would undoubtedly furnish satisfactory conditions for the storage of hydrocarbons were they introduced into the beds, but they do not furnish prospects for great concentration. If the field proves satisfactory it will have the character of one which will produce steady yields rather than sensational returns for a short period.

The evidence for the presence of petroleum, apart from the actual vicinity of Moturoa, where flowing wells occur, is based on the following:—

(1.) The existence of slight seepages of oil in various places remote from New Plymouth, and distributed over an area stretching from the sea near Waitara to the Waitotara River.

(2.) The existence of gas emanations over the same area, including those recorded by Clarke.* Outside the area, therein referred to, they are widely distributed, the most important occurrences being near Inglewood, at Huiroa, in the Mangaorie Valley, in the Waitara River. Such gas discharges are known to occur as far to the east as Whangamomona.

(3.) Beds of oil-bearing shale of lenticular shape, but not extensive in area, occur in several places, interstratified in the papa rocks.

(4.) In addition, there are sulphuretted-hydrogen and saline springs in various places, these not being in themselves evidence of the occurrence of petroleum, but are frequently associated with it.

(5.) The occurrence of mud volcanoes, which are frequently found in oil regions, has been recorded from various parts of the district, but the evidence on which these reports have been made is somewhat doubtful.

These various lines of evidence show that oil is found over a fairly wide area, but they do not show that it is found in sufficient quantities to be commercially valuable: that can be demonstrated only by boring. The original theory for the origin of Taranaki petroleum was based on the supposition that its distribution was very local, and entirely confined to the neighbourhood of Moturoa; but the evidence that it is widely distributed on the coast and inland between the Waitotara and the Mokau Rivers is

* Bulletin No. 14 (new series), N.Z. Geol. Surv., pp. 43–45.

very strong, so that any explanation of its origin must account for its occurrence near New Plymouth as well as in parts distant from that town, and must also be considered in connection with its distribution in beds of similar age and lithological character elsewhere in New Zealand where the conditions obtaining at Moturoa do not exist.

The first explanation of its origin was that advanced by Sir James Hector, who suggested that the petroleum was formed by the distilling action of the heated rocks of Paritutu and the Sugarloaves on the brown coal, which, it was supposed, continued from the Mokau River till it came in close contact with the igneous masses near Moturoa.

This hypothesis has been accepted by most geologists who have written on New Zealand geology, including Park and Bell. McKay has, however, considerable doubt about it; and Clarke, too, hesitates to accept it, but does not advance any theory of his own. That the volcanic rocks have had some effect is no doubt true, judging from the remarkable amount of carbon dioxide present in the gas given off in the wells (see analyses quoted, p. 46, Bull. No. 14, N.Z. Geol. Surv.), these results differing markedly from those given for other wells in the Taranaki District. The chemical constitution of the oil itself shows a notable percentage of constituents distilling at a high temperature, and points either to the more volatile matter having been driven off by the heat of the volcanic masses or its having escaped through fractures in the rocks Both of these circumstances may occur in the same locality, and in this case may be attributed to the igneous masses of Paritutu and the Sugarloaves, which have provided the requisite heat, and have also in all probability fractured and dislocated the surrounding beds when the intrusion took place.

In criticizing Hector's theory it may be pointed out,—

(1.) There is no evidence that the Mokau brown-coal measures do extend from the outcrops on that river to the neighbourhood of New Plymouth—a distance of approximately seventy miles—and, judging from the form of the coal areas in other parts of New Zealand, this is extremely unlikely to be the case. Most of these areas in New Zealand are marginal in character, and rarely continue over any wide expanse, although their length may be considerable; the seams, too, are lenticular in shape and are markedly discontinuous. If, however, there were other concealed coal areas lying on a pre-Miocene land-surface in the neighbourhood of north-west Taranaki, this objection would not apply.

(2.) Seeing that the action of volcanic heat cannot be responsible for the occurrence in districts remote from the centres of volcanic activity, some other cause must be looked for in order to account for its presence; and because the petroliferous beds near Moturoa are of the same age as those containing oil in other parts of the country, it seems reasonable that they owe it primarily to the same cause, even if local variations of conditions exercise a modifying effect. In advancing any theory for the origin, there is an important question to be considered—viz., whether the oil has originated in the papa beds or has migrated into them from some other beds, necessarily of more deep-seated position. It is likely, too, that both of these circumstances may be in existence at once, and that the beds owe part of the amount to accumulation *in situ* and part to migrations from other strata.

The fact that the Miocene mudstones are usually associated with petroleum indications, and also that where these beds do not occur the indications are scanty or absent, leads one to regard them as the locus of origin. As

far as present knowledge allows a conclusion to be made, indications of the occurrence of gas or oil are met with at horizons distributed throughout the whole thickness of these beds. It is true, nevertheless, that the amounts are greater at lower levels; but this is to be expected, since the more perfect cover afforded by the increased thickness of overlying strata naturally reduces the chances of the escape of oil. If it has originated *in situ*, the only possible explanation of its origin is that it is due to the distillation of the animal remains. The amount of vegetable matter included in these beds is small and seemingly insufficient to account for the phenomena, but a large amount of marine-animal matter does indeed occur. This includes remains of *Foraminifera*, and above all of *Mollusca*, whose shells are widely distributed, and at times form banks several feet in thickness. By the distillation of the animal matter they formerly were associated with, sufficient hydrocarbon would be furnished to account for the oil in the strata, and their wide distribution at various levels would account for the occurrence of oil through great depth. In this connection it may be noted that the oyster-beds associated with the coal-measures in other parts of New Zealand frequently give out a strong smell of petroleum when freshly broken. A reference has been made previously to the existence of beds of carbonaceous shale, which are interstratified in the papa rocks, but the origin of the carbonaceous matter is at present unknown. When analysed these show the presence of oil, and they furnish absolute proof that it does exist *in situ* in the Miocene beds.

The sandstone layers which are interstratified with the mudstones of this series would undoubtedly be suitable for the storage of the oil, and thick covering mudstones would favour its *retention*; but the structure of the country, as far as is known at present, hardly favours its *concentration*.

As regards the existence of a deep-seated source, it must be admitted that there is no direct evidence at present available from Taranaki. The most suggestive fact is that the surface indications and the flow of oil are specially strong in the immediate neighbourhood of the intrusive rocks near Moturoa. This may be explained by supposing that leaks have occurred up the surface of contact of these masses and the beds into which they have been intruded, and that the disruptions which would occur when the volcanic rocks were being forced into the surrounding sedimentaries would afford a relatively easy path for leakage through them from lower levels. There appears to be a close parallel between this occurrence and the sensational wells of the East Mexico field in everything but volume of flow.

Further, in the valley of the Waitotara River, along a line of fault, the surrounding clays are impregnated with hydrocarbons, and smell strongly of petroleum. This is certainly due to a leak, but whether it is a leak from a lower level in the Miocene beds or to a leak from a still lower horizon it is impossible to say. The strongest evidence of the deep-seated origin of the oil is, however, obtained from other localities.

In referring to the Kotuku district of the Grey Valley, Morgan says* that the Cobden limestone underlying the marls of that locality is charged with oil; unfortunately, nothing certain is known of its origin in that region, but the evidence undoubtedly points to a source below the limestone, and the impregnations of the overlying clays are due to upward migrations.

* Bulletin No. 13 (new series), N.Z. Geol. Surv., p. 143.

In summing up the position, Morgan says (p. 148), "It seems not unlikely that the source of the Kotuku petroleum may be at considerable depth, in a horizon corresponding to the Omotumotu beds, Kaiata mudstone, or Island sandstone. There is also the possibility of the oil originating in the Brunner or Paparoa coal horizons. The chief evidence, however, in favour of the view that the oil occurs at depth is based on the logs of the Brunner Company's Nos. 2 and 9 bores. These logs state that a little oil and gas occur all through the conglomerates that lie below the limestone. Since the bores were cased, a mistake as to the occurrence can hardly have been made, and therefore a deeper source than the conglomerate for all or much of the Kotuku oil must be regarded as the most probable. The small amount of benzene in the oil hitherto obtained supports the hypothesis of a deeper source than the argillaceous sandstone or the limestone."

In the Gisborne district, according to Adams,* the oil which occurs on the surface as well-marked seepages at Waitangi is derived primarily from a bed of oil shale which lies at the base of the Whatatutu series of the Survey. The author says (page 40), "As a result of the examination that has just been completed, it seems certain that the clay shales which form the lowest members of the Whatatutu series are the upper portion of or form the impervious cover for the oil zone of this area. Every sample of this rock which was obtained gave, when finely pulverized and subjected to strong heat, a decided smell of hydrocarbons. From its character, the clay shale is advisedly suited for a cover for a stratum containing oil."

These beds of the Whatatutu series are classified by Adams as of Miocene age, but it seems reasonable that McKay's classification of them as Cretaceous is more correct, since he found *Inoceramus* shells in them; and the report has been recently confirmed by the discovery of these fossils in boulders in the bed of the Waipaoa River in a matrix similar to that of the lowest beds of the series. This discovery apparently confirms McKay's classification, and we may therefore look on the shale, or the beds associated with it—probably the sandy beds—as the place of origin of the oil, and the fact that indications are to be found freely in the overlying clays which may be of Miocene age is attributable to migrations from a lower to a higher horizon. In this locality the only possible origin for the oil is an organic one, and almost certainly the oil has been derived from the remains of animal-life of a former sea-bottom.

In the East Coast district of Wellington the Miocene marls and clays are well developed, and under them lies, in all probability unconformably, a Cretaceous series.† Surface indications, such as gas emanations, are frequent in the overlying beds, but in all probability the major portion of the oil is derived from the lower series, in which black slaty shales are interbedded with clays and sandstones. These are well exposed near the coast, and have a general inland dip. The overlying marls are very thick—certainly over 3,000 ft., and probably over 5,000 ft.—and since they are marine in origin and contain traces of marine organisms it is quite possible that a part of the hydrocarbon matter they contain, and in some cases the whole of it, has been derived from the beds themselves and has not been accumulated by migration from the petroliferous beds underneath.

If we consider, therefore, that a deep-seated source of oil exists, then its probable mode of origin should be briefly referred to. The only accept-

* Bulletin No. 9 (new series), N.Z. Geol. Surv., Geology of the Whatatutu Subdivision.
† See Park, Geol. Surv. Report for the year 1887–88, p. 20.

able explanation is that it is due to the alteration of organic matter. This exists in two forms at the base of the Cretaceo-tertiary series—viz., as coals and lignites of vegetable origin, or as animal matter of marine origin Although the former is a possible source of the supply, it appears extremely unlikely that these coals have been depressed so far that the earth's internal heat has been sufficient to convert them into hydrocarbons. Our coals show little change unless they have been placed in close proximity to volcanic intrusives, in which case they are converted into altered brown coals or into mineral cokes or anthracites. The marine-organism explanation, therefore, is apparently the best solution of the problem. Below the limestones of Lower Tertiary or Upper Cretaceous age there lie almost invariably Greensands and other sands which contain a considerable amount of matter of organic origin. It has been noted previously that the black oysters associated with the coals of this series, when broken or struck with the hammer, give off a pronounced petrolaceous smell, and the remains of *Foraminifera* and other marine organisms are widely distributed through the Greensands. A thick band of these contains very generally a large quantity of sulphur, whose formation can certainly be attributed to the former presence of organic matter; and the frequent association of petroleum with sulphur compounds in other fields is also very suggestive in this connection.* A very illuminating paper by Daly in the "American Journal of Science," vol. xxiii, 1907, entitled "The Limeless Ocean of Pre-Cambrian Time," draws attention to the probable accumulation of organic matter which may occur under conditions similar to those obtaining in the Black Sea at the present time, and to the existence of large quantities of sulphur compounds associated with these accumulations. We have thus an explanation of the connection of sulphur with the large masses of organic material which could yield petroleum if buried under an impervious covering and subjected to the slow but sure chemical changes which go on in the crust of the earth, whether these changes be due to the transference of heat from lower levels in the crust, or to the action of bacteria, or to any other cause.

If, then, these sands and their associated beds be the locus from which the supplies of petroleum are derived, it becomes increasingly important when prospecting for oil in this country to know what thickness of the Miocene marls has to be penetrated in order to reach the underlying Cretaceous sands. In the North Island the marls are very thick—up to 5,000 ft., and perhaps much more. In the South Island the marls, with the exception of those in the Marlborough district, are comparatively thin; but they are usually folded with broken anticlinal crests, and it is probable that the greater part of the oil they may have once contained has escaped. There are places, however, such as Cheviot, which do undoubtedly give indications of the presence of oil in small quantities, and in these cases it may be reasonably supposed that the conditions favoured its retention for a longer period than elsewhere.

* See U.S. Geol. Surv., Bull. 398: "Geology and Oil Resources of Coolinga District, California," p. 187.

ART. XXXIX.—*The Geology of Tahiti.*

By P. MARSHALL, M.A., D.Sc., F.G.S., Professor of Geology, Otago University.

[*Read before the Otago Institute, 1st December, 1914.*]

Plate VII.

ALL those islands of the Central Pacific which have been examined geologically are either formed of coral rock or they are of volcanic origin. No sediments other than those that have the nature of coral detritus or of volcanic tuffs are known, with the possible exception of the coal-seams that are said to occur at the Island of Rapa.

In a few of the islands the occurrence of plutonic rocks has been recorded. Such records are, however, at the least, doubtful at Borabora, Maupiti, and at the Marquesas. At Sunday Island, in the Kermadec Group, there are certainly blocks of granite of considerable size and of some number embedded in a volcanic breccia.

In the Island of Tahiti, however, a series of plutonic rocks has been definitely proved to exist. The first record of these appears to be contained in Cuzent's work on Tahiti in 1860. Afterwards, in the year 1898, specimens were found in old collections previously stored in "l'ancien musée colonial," in Paris. These, like Cuzent's specimens, had been collected in the valley of the Papenoo, in which the Tuoru River flows.

Professor Lacroix at once realized the interest attached to these rocks, and in 1901 he induced M. Seurat to search for them. This distinguished biologist was at that time sent on a zoological mission to Tahiti in connection with the pearl-shell industry. The success of M. Seurat's geological work is described in the following words: "*M. Seurat à procédé à l'exploration hérisée de difficultés de toute la vallée de Papenoo et particulièrement de sa partie haute. Il est parvenu ainsi à trouver le gisement en place de la roche en question.*"*

With the aid of M. le Capitaine Courtet, who had at a previous time made a survey of the valley, a good map was drawn, and on it the geological information obtained by M. Seurat was inserted. This map was of the greatest value, as it was in all respects more accurate and more detailed than the official map used in Tahiti. So far as the lower course of the river was concerned, it appeared to be absolutely correct. It was not until we reached the upper part of the valley that any discrepancies were found between the map and the actual courses of the streams.

Professor Lacroix had hoped that the work of M. Seurat would have enabled him to decide the vexed point as to whether the plutonic rocks were the remnant of an ancient eroded land-mass, or whether they were masses intrusive into the basaltic series of which the island is almost entirely composed, in the same way as the gabbros are intrusive into the lavas of the Hebrides. In this important respect the results were inconclusive, for he says, "*Malheureusement, je ne suis que poser ce problème. M. Seurat m'a dit n'avoir pas vu de blocs de couleur clair dans les tufs basaltiques, mais les researches précises seraient nécessaires pour élucider ce problème.*"†

Matters resting in this rather unsatisfactory state, advantage was taken of a visit to Tahiti in August, 1913, made with the aid of a grant from the

* Lacroix, "Les roches alcalines de Tahiti," Bull. Soc. Géol. de France, 4e série, t. x, 1910, p. 92.

† Lacroix, *loc. cit.*, p. 97.

Australasian Association for the Advancement of Science, for research on the alkaline rocks of Australasia.

Letters written previously to the Governor, M. Léon Géraud, received replies which assured me of every assistance in the project of ascending the Papenoo Valley, which was said to be "*hérisée de difficultes*" and "*il n'existe pas de sentier bien tracé et on doit se frayer soimême son chemin.*"

On my arrival in the colony M. Géraud kindly gave me a letter to the chief of the Village Papenoo, situated at the mouth of the River Tuoru, and he promptly furnished us with the necessary guides. It was extremely fortunate that one of these, Teaeo by name, had accompanied M. Seurat when he made his geological collections in the valley. This enabled me to find his localities with the utmost certainty and with the least loss of time.

The entrance to the Papenoo Valley is about 300 metres wide, and its sides rise precipitously to a height of 100 metres at first, but they ascend gradually towards the interior of the island. Its floor is covered with gravels, in which boulders of plutonic rocks of some variety are quite common. These vary from pure white types to dark theralites, many of which contain conspicuous crystals of hornblende and augite. Mixed with these there is a great variety of basalts, and a few of tinguaite and monchiquite.

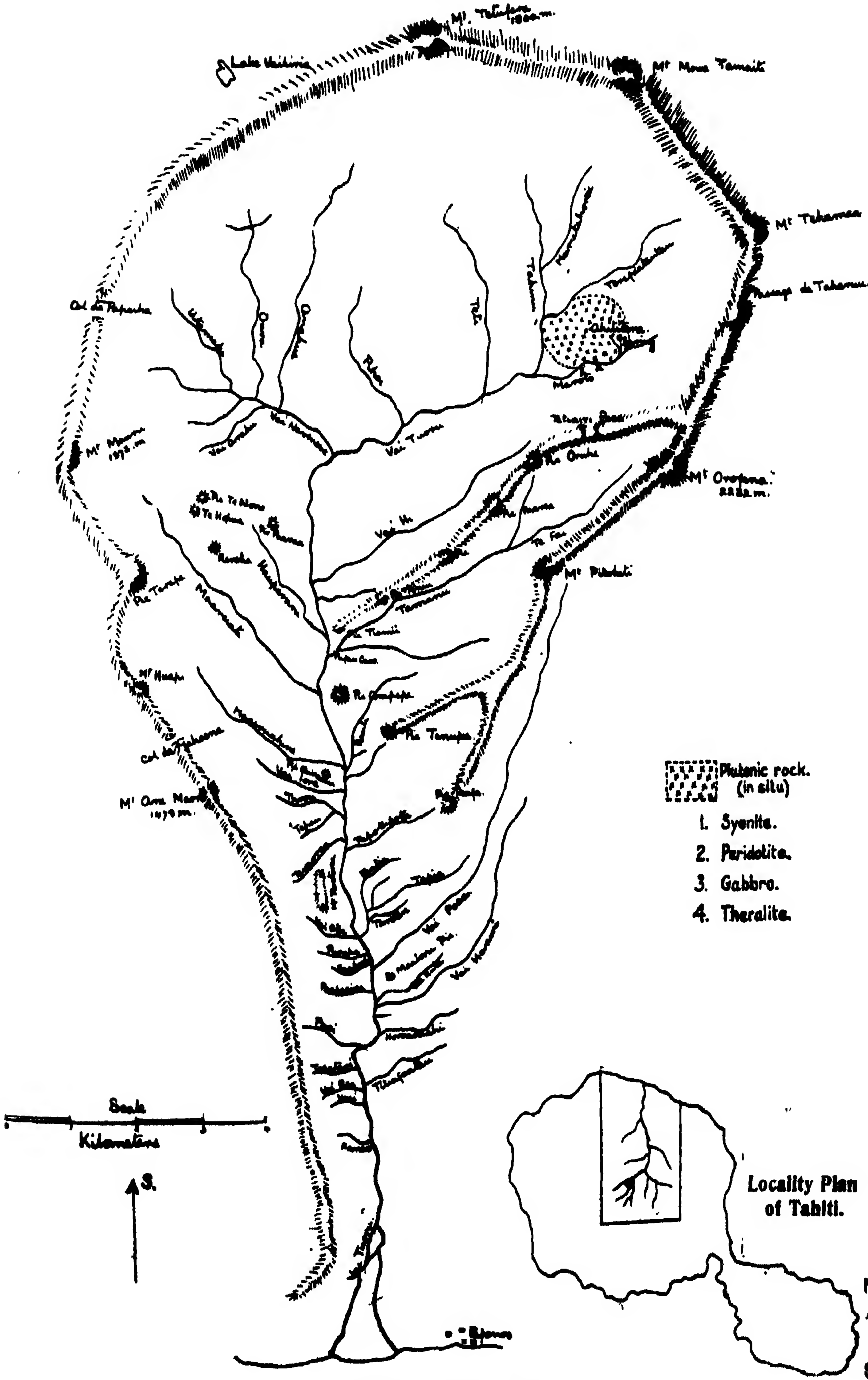
The river maintains a wide floor as far as Tiamii (see map of valley), about 9 kilometres from its mouth. Here the Tamanu tributary branches off from it. This stream drains the east and north of Orofena, the highest peak of the island. In its gravels there were no boulders of plutonic rock. Above this point the Papenoo Valley narrows rapidly, and in many places flows over the native rock.

Close to Tiamii an area of plutonic rock is indicated by Seurat. The guide Teaeo showed me a large boulder in the forest, which he said was the outcrop discovered by Seurat. It was clearly a transported boulder, and I could find no outcrop of plutonic rock near it, though basalt occurred *in situ* 100 metres farther up the stream.

The same was found to be true at the mouth of the Navenave and Pihoi, other localities where plutonic rocks had been reported *in situ* by Seurat. In both of these places large boulders of plutonic rocks were to be seen in number, but no rock other than basaltic breccia could be found in place. From a point a little beyond the mouth of the Pihoi our track led some distance above the bed of the Tuoru across the small stream Teti. Here again the only plutonic material that was found consisted of large boulders evidently water-borne. The bed of the Tuoru was not seen near this place, so I am not able to say whether the plutonic occurrence recorded by Seurat at this place is correct, though, as far as appearances went, it appeared unlikely that it was so.

Shortly above the junction with the Teti the Tuoru forks into the Maroto and the Tahinu. My guide (Teaeo) asserted that Seurat went no farther than the junction with the Teti. Lacroix, however, states that Seurat went for some distance along the bed of the Maroto, and found that the plutonic boulders soon disappeared, and that the upper part of the valley is constituted entirely of basalt. There must be some mistake here, for at the junction of the Tahinu and Maroto there is nothing but volcanic rock *in situ*, while a little farther up the Maroto plutonic rock is to be seen forming the bed of the stream, and it continues to form its banks for some distance.

It thus appears that in all but one of the localities where Seurat is stated to have found plutonic rock *in situ* I was unable to find any, and this one I was not able to visit.



PAPENOO VALLEY, TAHITI.

In the bed of the Tahinu, about a mile above the point where the river joins the Maroto, there is an outcrop of white syenite which extends for about 100 yards along the bed of the stream. This rock is seamed most irregularly by thick and thin dykes of a dark rock of a diabasic nature. Two hundred metres above the syenite outcrop the Tahinu again branches, and the right-hand branch retains the name Tahinu. In the bed of this stream no boulders of plutonic rock could be seen; all the boulders had a basaltic appearance. In the bed of the left-hand branch, the Terefaatautau, plutonic boulders of various natures were quite frequent. This branch was followed for a short distance, but no rock was seen *in situ*. The proportion of boulders of plutonic rock slightly decreased, and the stream in this part of its course was relatively open, and not enclosed in a gorge.

The Maroto branch was not followed for some distance from its junction with the Tahinu, but it was found that about half a kilometre above that point it cuts through a plutonic rock (gabbro). A short distance farther on a small tributary which joins it on the right contained no boulders of basalt, but a great variety of large boulders of plutonic rock. Another half a kilometre farther on the stream showed a large exposure of peridotite. A little distance farther on there was close to its right bank an occurrence of a highly porphyritic theralite containing large crystals of hornblende. Above this point the stream contained as many boulders of basalt as of plutonic rock. Nearly a kilometre farther on, and at a short distance from the right bank, there was a large outflow of spring-water of a strongly ferruginous character. The water was highly charged with a gas which had no smell and would not support combustion; it was probably carbon dioxide.

The rock near the spring was much decomposed; it contained large crystals, and appeared to be a theralite. This spring was said by my guide to be Vai Apaaoa, which in Lacroix' map is placed on the left bank of the Maroto. All the ground near this spring is saturated with spring-water, and the soil is everywhere red with iron oxide. The water of a neighbouring stream is as great in volume, and contains ferruginous matter to as great an extent, as Vai Apaaoa, and it is evident that there is close at hand another spring as large as the one that we saw. The water of these springs, which is quite cold, tinges the whole of the water of the Maroto a ferruginous tint. The water of the Tahinu is tinged in a similar manner near the outcrop of syenite, and spring-water is everywhere escaping in some quantity near the main stream. This evolution of spring-water may account for the fact that the syenite contains a considerable quantity of pyrite. Above its junction with the Terefaatautau the water of the Tahinu was quite clear, and in the Terefaatautau there was very little discoloration due to spring-water. It appears, then, that the evolution of spring-water occurs only in the area of plutonic rock, and, so far as observed, the escape of the spring-water was greatest near the margin of the plutonic rock.

On the left side of the Maroto, opposite the spring Vai Apaaoa, no plutonic rock was seen on the side of the hill which forms the watershed between the Tuoru and the Tamanu.

From the summit of this watershed at Tetiairi Pass a good view was obtained of the whole of the central basin of the island. The general form of this basin was now disclosed, and was seen to fully justify the expression of Meinicke: "*Liegt er an der Westseite eines grossen runden Bergkranzes der das Thal des oberen Papenoo flusses umschliesst.*"*

* Meinicke, "Inseln des stillen Oceans," Zweiter teil, p. 164. Leipzig, 1875.

From the point where the Navenave joins the Tuoru the whole of the basin of the Upper Papenoo, about 5 kilometres in diameter, is enclosed by a rampart of astounding mountain-peaks, which, however, do not actually include Orofena (2,230 metres). The highest peaks of this rampart certainly nowhere rise to a greater height than the 1,800 metres of Tetufera (Plate VII, fig. 1), and the 1,476 metres of Tamaiti, yet their acclivities are most abrupt. Even at the locality where syenite outcrops in the Tuoru bed the elevation is only 320 metres above sea-level, and for some distance toward the mountain the slope is but slight. Along this nearly circular wall the summits rise in remarkably sharp aiguille peaks (Plate VII, fig. 2), and in two places the wall is pierced by relatively low passes, one of which —Urufaa—is only 884 metres above sea-level, and leads to the lake Vaihiria, on the south-eastern slopes of the island.

The central part of this impressive amphitheatre is occupied by a low hill—Ahititera—about 850 metres high (Plate VII, fig. 1). Its surface is rounded and smooth compared with the steep precipices and aiguille peaks of the surrounding mountains. This hill—Ahititera—is drained on its two sides by the Terefaatautau and the Maroto respectively. Its summit consists of a rocky mass, which, unfortunately, was not seen before our viewpoint was reached. Our food-supply and other considerations did not allow of time for visiting this peak, from which as a central point the surrounding landscape must be wonderful. Specimens, too, were not obtained from it. The guide Teaeo, whom I found most accurate in all of his topographical statements, assured me that it was formed of a *roche grenue*, and his information was strongly supported by the appearance and weathering forms of the rock.

The topography of the country strongly suggested the opinion that this relatively low conical hill was composed of plutonic rock, as was actually the case so far as that part of it which I had visited was concerned. The essentially different nature of the surrounding hills suggested also that they were formed of a different kind of rock-series. This opinion is supported by the fact that in the Upper Tahinu, judging by the nature of the boulders in its bed, nothing but basalt outcrops. In the Upper Navenave and Pihoi there is said by M. Seurat to be no indication of the outcrop of plutonic rock. In the main stream I found no plutonic material *in situ* until the white syenite was reached on the east side of the hill Ahititera, and in the gravels of the Terefaatautau and Maroto boulders of plutonic rock became less numerous as the stream-beds were ascended.

It thus appears that, so far as my observations go, the whole area of plutonic rock is practically confined between the beds of the Tahinu, Terefaatautau, and Maroto Streams—that is to say, the area of the hill Ahititera.

PETROLOGY.

The plutonic rocks of the Papenoo Valley, of Tahiti, have already been shown by Lacroix to be of special and somewhat peculiar interest, for they include alkaline rocks which here, as elsewhere, display a great variety. Lacroix compares them with those of Madagascar, from which island he has described a similar series. All but one of Lacroix' types contain a feldspathoid mineral, principally nepheline; and they all lie between nepheline syenite and essexitic gabbro. He classes them as follows :* *Syénites néphéliniques, monzonites néphéliniques, gabbros néphéliniques, gabbros essexitiques.*

* Lacroix, *loc. cit.*, p. 121.

None of these types were, however, found *in situ*, though the large boulders that were found suggested that this was the case. It was my good fortune to extend this series at both ends by additional specimens of plutonic rock actually found *in situ*. On the one hand, in the bed of the Tahinu, as mentioned before, there was a syenite wanting in nepheline, and of a more acid character than any of the rocks described by Lacroix. On the other hand, there was a peridotite in the bed of the Maroto which in a sense corresponds among the plutonic types to the picrite mentioned by Lacroix as occurring in the volcanic series. The plutonic rocks of the interior of Tahiti thus form a very complete series from acid to peridotite types, through a great variety of alkaline varieties.

Syenite.

Hand-specimens of this rock are nearly quite white, though they show a few plates of biotite, and contain a great many very minute crystals of pyrite.

In section the rock is found to consist almost solely of an alkaline feldspar in allotriomorphic crystals. The albite twinning is very general, but irregular, and the mineral is almost certainly anorthoclase or a fine perthite. It is considerably decomposed, and in some cases the product of decomposition is distinctly muscovite. There is a little biotite in rather large crystals, with intense pleochroism, from pale-straw colour to nearly black. Small crystals of pyrite are scattered through the rock rather plentifully. Sphene, which is so abundant in the nepheline syenites and monzonites, and to some extent in the theralites, is in this rock almost entirely wanting. (For analysis, see page 371.)

Gabbro.

This was found in a small gorge where an ill-defined pig-hunting track of the Natives crossed the Maroto, apparently about half a mile above the point where the Maroto joins the Tahinu. In hand-specimens the rock is moderately coarse-grained, the feldspar predominant over the augite, but a quantity of magnetite is to be seen.

In section the feldspar is found to be bytownite. It is in small grains, and its crystal outline is seldom complete. All the feldspar is fresh and well twinned. The augite has a very slight violet tint, and is not noticeably pleochroic. Ilmenite is abundant in the section. It occurs in sharp crystals, bordered by a thin reaction rim. Frequently there is a small amount of biotite associated with the ilmenite, but this mineral is not to be seen elsewhere in the section. No sphene was seen.

Peridotite (Wehrlite).

A black rock, in hand-specimens showing a small amount of serpentine, and clearly granular in structure. In section, augite is found to be the most abundant mineral. It does not show the distinct violet colour which characterizes this mineral in the great majority of plutonic rocks of this island. The crystals are of moderate size, and show few regular crystallographic planes. Olivine is fairly abundant. It is much fractured, and the crevices are filled with magnetite. The olivine does not show crystal boundaries. Associated with it there are patches of colourless crypto-crystalline matter, in which a few grains of iron-ore can be seen. This crypto-crystalline matter is very fine-grained, and has a low refractive index, with very high birefringence. Where it borders the augite it has sharp clear-cut

boundaries, indicating, of course, that it was the last mineral to crystallize. A little dark-brown biotite is associated with the olivine. There is no iron-ore apart from that associated with the olivine. (For analysis, see page 371.)

It will at once be evident that the discovery of these types considerably extends the series previously described by Lacroix, who has already commented on the close relationship between the various members. An extension of the series in the basic direction was clearly foreseen by him, for he recognized that an ultra-basic plutonic would probably exist to represent the picrite which he had distinguished among the basalts. This picrite, however, contains some feldspar, and it is thus less completely ultra-basic in a mineralogical sense than the peridotite just described.

In the acid direction the series of Lacroix is still further extended, for the most acid type described by him—the *syénite néphélinique à biotite*—contains only 52·25 per cent. of silica, whereas the syenite now found *in situ* in the bed of the Tahinu contains 61·06 per cent. of silica, notwithstanding the considerable amount of pyrite in the rock. This syenite contains a slight excess of potash over soda—a feature that was noticed by Lacroix also in his *syénite néphélinique à biotite*, though in all the other rocks of the series there is a considerable excess of soda over potash.

It is thus apparent that in this small area there is a plutonic series extending from a syenite with potash in excess of soda, and consisting almost entirely of alkaline feldspar, through various types of monzonites, essexites, theralites, and gabbros to a peridotite with absolutely no feldspar.

Professor Lacroix, in 1910, mentioned a specimen of granite which had been collected at Tautira, on the north side of the Peninsula of Taiarabu. Père Alain, of L'École des Frères, at Tahiti, kindly gave me a specimen of a similar granite which had been given to him as coming from Tautira. As Lacroix said, "*S'il provient du sol de l'île il y aurait là un fait d'une grande importance.*" A visit was accordingly made to Tautira, and a specimen of the granite was shown to various Natives, who all agreed that they had never seen such a rock anywhere in the district. The chief, Ori a Ori, in particular, was emphatic in the statement that he had not seen a rock of this nature in the mountains, or anywhere else in the country. A diligent search was afterwards made in the river-gravels and on the sea-beach for boulders or pebbles of granite, but entirely without success. It seems that this granite, if it ever really came from Tautira, had been previously brought there as ballast or for some other purpose by some visiting vessel.

Though no granite pebbles were found at Tautira, pebbles of plutonic rock were not infrequent in the gravels of the Tautira River. These were found to be specimens of a highly feldspathic olivine gabbro similar in many respects to the specimens from the Papenoo Valley.

Dyke Rocks.

Specimens of tinguaites, monchiquites, and camptonites have already been described from the material brought from the Papenoo Valley by M. Seurat. I found that boulders of tinguaite were not common in the material of the river-bed, and I was unable to find any in place. One of my guides—Mauri—however, told me that the *roches vertes* were to be found in some abundance in the gravels of the upper part of the Teti Valley, but I had no time to attempt to verify his statements. Boulders of monchiquite were quite common among the boulders of the Papenoo Valley.

As stated by Lacroix, there is every variation between the rocks classed by him as monchiquites and camptonites; that is, between hornblende lamprophyres which have a basic feldspar in the finer constituents of the groundmass and those that have analcite. I did not find any dykes of monchiquite *in situ*.

Numerous dykes were found seaming the syenite. These, however, are of a diabasic type. The rocks contain an abundance of augite, always in small crystals with idiomorphic boundaries, and occasionally forming small group of five or six radiating individuals. Feldspar is not abundant. It has the moderate extinction-angle of andesine. There is a little serpentine, obviously derived from olivine. Some epidote occurs in somewhat irregular patches. There is much magnetite. A little brown hornblende is found where residual fluid matter has oozed into pores of the rock. A mineral is present in the form of small irregularly lath-shaped crystals with a high refractive index and high birefringence. It has the small extinction-angle of 6° and a pronounced longitudinal cleavage. It is almost colou less, and may be a variety of hornblende. Except for this type, no dyke rock was found in place.

Volcanic Rocks.

The greater number of volcanic rocks that were found in Tahiti were basalts; in fact, this type appears to be the only one which occurs in the vicinity of Papeete, though, of course, its structure, and to some extent its composition, varies somewhat widely. An extremely coarse type with large idiomorphic crystals of augite is found in the bed of the small stream Rivière de la Reine, about 1 kilometre west of Papeete. Another type with large grains of olivine always surrounded with a red oxidized border is quarried for road-metal on the main road 3 kilometres west of the town. This rock contains small crystals of augite only in the groundmass, and very little labradorite feldspar, though iron-ores are plentiful. In the valley of the Papenoo boulders of basalt are more common than those of any other kind of rock. They are often vesicular, and in the vesicles there is a considerable variety of small crystals of zeolite.

One of the largest outcrops of basaltic rock that was seen occurred in the valley of the Papenoo, about 5 kilometres from its entrance. This outcrop extended from the Vai Rutu to Maoma. It forms cliffs rising to a height of over 100 metres above the floor of the valley, and shows a distinct columnar structure. In section the rock is found to consist of crystals of olivine, mostly idiomorphic, and of moderate size, embedded in a plexus of small brown crystals of augite. There are small grains of magnetite and a little residual dark-brown glass crowded with feathery crystals of ilmenite. In hand-specimens the rock is quite black, and the only mineral which can be distinguished is olivine. This rock is quite a typical limburgite, distinguished from the picrite of Lacroix by the entire absence of feldspar.

At the entrance to the Vaihi tributary of the Tuoru there is a zeolitic basalt *in situ*. It contains no olivine. The augite is of a pale-brown colour, in long slender crystals. The feldspar is in the form of very slender microlites arranged in the form of delicate feathery growths. This is certainly one of the older lava-flows of the island volcano.

Hauynophyre.

The rock of this class previously described from Arue (Rep. Aust. Ass. Adv. Sci., vol. 13, 1912, p. 196) could not be found *in situ*. The road-

cuttings near at hand, where the road round the island passes over a projecting spur, show nothing but basalt lavas, and it becomes evident that the small stream in the bed of which the pebbles of hauynophyre are found have been transported from a considerable distance. This is at present the only lava rock of the island in which hornblende has been found.

Another rather different hauynophyre was, however, found *in situ*. This rock forms a high cliff at Tapahi, 20 kilometres east of Papeete. This rock contains a few grains of olivine, which have a thin border of iron oxide, and are entirely surrounded by augite. Pale-brown phenocrysts of augite occur, but they are not plentiful. The crystals of hauyne are of moderate size. They are dark blue in colour, but they weather readily to a pale-yellow tint. The hauyne contains a great abundance of inclusions of a black colour, which in many cases make the mineral quite opaque. The groundmass contains much augite in elongated microlites. Feldspar forms irregular microlites of small size: they are apparently anorthoclase. There is a little nepheline, quite allotriomorphic, and a great deal of magnetite.

A slip about 200 metres farther down the Tahinu than the outcrop of syenite discloses a highly weathered light-green rock, from which, however, a sound specimen was obtained. The greater part consists of small irregular crystals of feldspar (andesine) with much pale augite also in small crystals, and contains a number of inclusions of magnetite. There are some patches of irregular grains of brown hornblende. There are a few grains of olivine, which are much dusted with magnetite throughout, and are occasionally changed into a highly birefringent crypto-crystalline substance that could not be identified.

Another lava outcropping about 50 metres down-stream from the syenite outcrop proved to be a dolerite. It contains large crystals of pale-brown augite with a dark border. Labradorite feldspar is plentiful. Magnetite and ilmenite are abundant, and there is much olivine dusted with magnetite throughout.

These lavas have evidently been considerably affected by the high temperature due to the adjacent pipe of the volcano which was built up to a height of 2,000 metres above them after they had been ejected.

From the account given here it will be seen that the occurrence of plutonic rocks in the island of Tahiti is quite different from that indicated in the map published by Lacroix, which was based on the collections and observations of Seurat. The large exposure of these rocks over the greater part of the Upper Papenoo Valley which is shown in the map was not found by me. The actual exposure seen was situated almost entirely between the beds of the Tahinu and Maroto Streams. Here the ground has a relatively gentle slope, in marked contrast with the precipitous slopes of the hills around. The top of the conical hill—Ahititera—formed of these plutonic rocks does not rise to more than 850 metres above sea-level. The plan of the island shows that this area is almost exactly the centre of the whole island. Within this plutonic area there is found to be a great variety of rock types, actually varying from an acid syenite to a peridotite. The greater part of the area, however, judging at least from the preponderance of boulders, appears to be formed of the more alkaline types, from nepheline monzonite to theralite. This, however, has not yet been demonstrated by the actual location of the outcrop, partly because the tropical vegetation and weathered rock-matter largely obscured the outcrop, but mainly because of the lack of time available for work.

So far as the actual located outcrops are concerned, the extreme types appear to be marginal in their occurrence, while the main mass of the central hill—Ahititera—seemed to be composed of monzonitic rocks, judging by the boulders contained in the beds of the streams that radiate from the hill. It was most unfortunate that the slopes of Ahititera were not more closely examined, but as our route had led along a stream-valley in mountainous country covered with tropical forest it was not possible to get an idea of the topography of the country until the viewpoint from the pass Tetiairi had been reached, and it was then too late to return.

As stated previously, the hill Ahititera, over which the outcrop of plutonic rocks occurs, is the actual central area of the island. This hill is almost entirely surrounded by a circle of high mountain-peaks, composed apparently of lavas and breccias, and from these peaks the land slopes outward without steep average slopes in all directions. It is, however, radially furrowed by deep radiating valleys separated by the knife-like ridges so well described by Darwin and Dana. On the west side only is there any exception to this statement. There Aorai and Diadême extend the high country somewhat to the west of the upper part of the Papenoo Valley.

When this arrangement of a small plutonic area surrounded by a circle of volcanic rocks, and of this central hill surrounded by a ring of lofty peaks, is borne in mind, only one conclusion as to the structure of the island can be arrived at. It appears obvious that the plutonic area marks the position of the much-denuded remnant of the plug filling the pipe through which the volcanic rocks were ejected. If this reasonable conclusion be accepted, it will be seen that the original volcano of which Tahiti was formed reached a height of at least 3,000 metres, for the dissected and worn remains still attain an elevation of 2,232 metres in Mount Orofena, which stands some distance back from what was probably the central orifice of the volcano. Here, then, we have the materials of a volcanic plug exposed by erosion and weathering at a depth of 2,000–2,500 metres below the summit of a volcano the ruined flanks of which still rise up in a mighty rampart to a height of 1,500 metres or more on every side.

The plutonic rocks of the central plug of the volcano are mainly of an alkaline nature, lying between monzonite and theralite. The volcanic rocks are mainly basalts, though hauynophyres and phonolites also occur. There thus appears to be something of a discordance between the plutonic and volcanic types, and this even suggests that there is no community of origin between them. This discordance is of a specially marked nature mineralogically, for whereas almost all the plutonic rocks contain a large amount of nepheline, brown hornblende, and often biotite and sphene, the volcanic rocks contain practically none of them.

This difference is, however, far more marked mineralogically than chemically, as has been well shown by Lacroix. The analyses that he has published show quite clearly that the chemical differences between his *gabbro néphélinique* (theralite) and *gabbro essexitique* on the one hand, and of some of the basalts on the other, is quite slight. Again, the *syénite néphélinique à amphibole* and *monzonite néphélinique* on the one hand are also chemically equivalent to the hauynophyres on the other. The discovery related here of the plutonic rocks syenite and peridotite now provide equivalents for the phonolite and picrite of Lacroix among the volcanic rocks.

It thus appears that from a chemical standpoint there is a satisfactory equivalence between the plutonic and the volcanic rocks of this island.

To some extent at least the great mineralogical difference that has been mentioned can be explained. It appears that hornblende and mica do not crystallize in an igneous magma unless some mineralizer is present. Thus Doelter says, "*Was die hornblende anbelangt, so wird vielfach die Notwendigkeit von Wasser und hoheren Druck angenommen. Keinenfalls ist ihre Bildung ohne Mitwirkung von Mineralisatoren moglich, ebensowenig wie bei Glimmer . . . Bezuglich der Hornblende hat Becke der Einfluss des Druckes auf ihre Bildung studiert und scheint jedenfalls wenigstens eine geringe Druckzunahme ihre Entstehung zu fordern.*"*

At the time of an eruption of magma the water, and probably any other mineralizer, would escape, and there would then be no chance of hornblende forming. A new molecular arrangement within the magma would be the result. This might well end in the crystallization of the minerals of a normal basalt. It is noticeable that, while theralites and nephelinitoid monzonites are apparently the commonest types of plutonic rocks, basalts are by far the commonest types of volcanic rocks.

Lacroix has already shown that a clear relationship of a chemical nature exists between his *monzonite néphélinique à biotite* and the hauynophyre. It can be clearly seen from the accompanying table that the syenite mentioned in these pages is a chemical representative of the phonolite described by Lacroix as coming from Vairao. The peridotite also obviously belongs to the same chemical class as the picrite he has described. The table of analyses given here is taken from his paper, but the analyses made by me of the syenite and peridotite are added to it.

Plutonic Rocks.

	A.	B.	C.	D.	E.	F.	G.
SiO_2	61·06	52·25	51·31	47·50	45·10	41·50	43·92
Al_2O_3	16·04	18·70	20·07	19·97	19·30	12·31	3·16
Fe_2O_3	7·02	2·55	3·10	3·39	1·55	5·20	5·24
FeO	0·40	3·69	2·50	4·74	8·70	8·46	6·20
MgO	0·72	1·78	1·02	3·60	5·30	11·29	20·71
CaO	0·70	3·95	3·57	6·92	9·81	14·05	12·42
Na_2O	5·27	5·10	6·50	5·25	4·32	2·06	0·34
K_2O	6·43	6·62	5·38	3·47	1·58	0·48	0·07
TiO_2	0·78	2·29	1·92	2·96	3·49	4·78	3·46
P_2O_5	0·06	0·20	..	0·44	0·57	0·06	0·02
H_2O	0·43	2·75	3·85	2·25	0·75	0·50	4·16
S	4·21	..	..	..	..	..	..
	103·12	99·88	99·85	100·49	100·47	100·69	99·71
Subtract O_2	2·34						
	100·78						

A. Syenite with pyrite and a little biotite. Analysis, P. Marshall.
B. *Syénite néphélinique à biotite.*
C. *Syénite néphélinique à amphibole.*
D. *Monzonite néphélinique.* Analysis, M. Pisani.
E. *Gabbro néphélinique.*
F. *Gabbro essexitique.*
G. Peridotite (wehrlite). Analysis, P. Marshall.

B, C, D, E, and F quoted from Lacroix, "Roches alcalines de Tahiti," Bull. Soc. Géol. de France, 4ᵉ serie, t. x, 1910, p. 121.

* C. Doelter, "Petrogenesis, Braunschweig," 1906, p. 146.

Roches Microgrennes.

		A.	B.	C.
SiO_2	..	56·40	46·10	44·26
Al_2O_3	..	21·41	19·91	13·32
Fe_2O_3	..	1·04	2·75	4·60
FeO	..	1·50	5·02	8·19
MgO	..	0·51	3·30	9·42
CaO	..	0·96	6·95	10·95
Na_2O	..	9·61	6·10	2·40
K_2O	..	5·36	3·62	0·99
TiO_2	..	0·25	3·02	5·02
P_2O_5	..	..	0·25	0·45
H_2O	..	2·50	2·99	0·37
		99·54	100·01	99·97

A. Tinguaite. B. Camptonite. C. Microgabbro.

All analyses by H. Pisani, Lacroix (*loc. cit.*).

	–	A.	B.	C.	D.	E.	F.	G.	H.	I.
SiO_2	..	60·50	49·52	48·70	46·25	48·64	44·25	44·75	43·85	42·30
Al_2O_3	..	18·20	19·40	19·12	19·00	17·04	16·27	13·22	9·07	12·74
Fe_2O_3	..	1·34	2·08	2·40	4·65	3·32	1·50	1·20	..	..
FeO	..	1·89	5·15	4·77	3·60	6·14	10·30	10·50	10·75	10·60
MgO	..	1·18	2·12	1·54	2·20	2·58	6·51	10·85	23·40	12·74
CaO	..	1·75	6·51	6·25	6·61	5·79	10.14	11·50	7·90	13·01
Na_2O	..	7·25	7·15	7·83	6·10	7·16	3·24	1·95	1·30	2·65
K_2O	..	4·45	3·85	3·45	3·62	3·02	1·98	1·27	0·54	0·94
TiO_2	..	0·92	3·30	2·37	2·78	2·06	3·65	3·45	1·88	1·51
	SO_3	..	0·41	0·83	0·55	0·04	..	..	..	..
P_2O_5	..	..	..	..	..	..	0·63	0·38	0·38	..
	Cl	..	0·15	0·13	0·25	0·20	..	..	..	..
H_2O	..	2·30	0·50	2·80	4·38	3·20	2·40	1·62	1·62	2·54
		99·78	100·14	100·19	99·99	99·21	100·87	100·69	100·69	99·03

A. Phonolite. B, C, D, E. Hauynophyre. F, G. Basalt. H. Picrite. I. Limburgite.

A, B, C, D, F, G, H, analyses, H. Pisani, Lacroix (*loc. cit.*); E, analysis, P. Marshall (Rep. Aust. Ass. Adv. Sci., vol. 13, 1912, p. 197); I, analysis, P. Marshall.

Daly has lately, as is well known, suggested that the alkaline igneous rocks are due to the solution of masses of limestone in a magma of sub-alkaline composition. There appears to be no evidence in support of this theory so far as our knowledge of the alkaline rocks of the South Pacific islands allows us to form a judgment at the present time. Though volcanic tuffs and breccias are of common occurrence in the Pacific islands, and though they have been examined carefully in several places, no fragments of limestone or sedimentary rock have yet been discovered in them, nor has any material of this kind been found in the lava itself. It is true that Daly, in his summary of the field associations of alkaline rocks in different parts

of the world, inserts a query as to the possibility of carbonate rocks being cut by the eruptive rocks of Tahiti.*

All round this island the ocean-floor quickly falls to a depth of about 2,500 fathoms, and its surface is covered with volcanic mud, or with this material mixed with globerigina ooze or with red clay.† There appears to be no reason to suppose that before volcanic activity commenced on the site of Tahiti the ocean-floor at that particular spot was in any way different from its nature in the closely adjacent area. Over this area the ocean-floor is at such a depth that the calcium-carbonate remains of organisms have already been partly dissolved and the percentage of silica has become considerable.

The question also arises as to whether any instances are known where basic magmas have invaded limestone and have acquired in consequence a local alkaline character on the borders of the magma. So far as New Zealand is concerned, we do not at present know of any district in this country where basic magmas have invaded limestone rocks. There is, however, a striking instance of a large acid batholite in contact with a limestone deeply buried at the time of the intrusion of the magma. This example has been described by Webb, Bell, and Clarke.‡ Here the great intrusive mass of granite of the Pikikiruna Boss is in contact with a crystalline limestone of Ordovician age. Basic rocks are the result of the contact, and patches of basic rock due apparently to absorption and solution of limestone are found at some distance within the granite. There appears to be no evidence, notwithstanding the obvious evolution of quantities of carbonic-acid gas, of any great disturbance of the magma, or of any influence of the absorbed limestone, on the whole mass of the granite, but only on localized portions of it. No development of alkaline types is noticed. Similarly, in the district of alkaline volcanic rocks at Dunedin, New Zealand, where a highly arenaceous limestone of Cainozoic age underlies the volcanic rocks, no evidence has so far been found that any solution of this material has taken place.

In the actual field occurrence of the plutonic rocks in the Papenoo Valley, Tahiti, the occurrence of acidic types and ultra-basic types within a short distance of one another appears to preclude the idea of absorption of calcareous matter. There is every reason to believe that the outcrop is at a level of at least 10,000 ft. to 15,000 ft. above that at which absorption has to be supposed. Upward movement through this distance would cause the complete mixing of the absorbed matter. Yet here we find a complete separation of the magma into rocks of which one at least cannot be regarded as a desilicated type.

The rock-specimens found on the beach at Tautira and in the gravels of the Tautira River included gabbros and phonolites. The Tautira River is the largest in the Taiarabu Peninsula, and, judging by the map, it appears to have a large circular basin in the centre of the peninsula. There can be no doubt that this peninsula was an independent volcano, and the Tautira River appears to have the same relation to it as the Papenoo has to the main island. In other words, the Tautira appears to have drained the original crater, and now that denudation is far advanced its basin includes

* Daly, "The Origin of Alkaline Rocks," Bull. Geol. Soc. Amer., vol. 21, 1910, pp. 87–118.

† Agassiz, Mem. Mus. Comp. Zool., vol. 28, plates, pl. 202.

‡ N.Z. Geol. Surv. Bull. No. 3 (new series), 1907, p. 73.

the denuded plug that fills the pipe through which magmatic matter rose to the crater. The variety of plutonic rocks found here, however, was quite small, a fact that can be explained by the smaller size of the Taiarabu volcano, and therefore by the less extent to which denudation has laid bare the deeper portions of the plug. There was, unfortunately, no opportunity of making geological observations in the valley of this river.

It will at once be seen that there is in Tahiti a splendid opportunity of studying the differentiation that has taken place in the magma that filled the pipe of a volcano of large dimensions at a depth of 2,000 metres below the actual crater, and of the correlation of these differentiates with the lavas that have issued from the crater from time to time. It happens, however, that a lack of time and means have prevented anything more than a mere locating of a few of the plutonic types, and but little has yet been done in finding the extent of the different lavas. The present paper merely calls attention to the excellence of this field for study.

It may, however, be noticed that the rocks of Tahiti appear to be merely typical of those of most of the volcanic islands of the Eastern Pacific. Thus, nothing but basic and alkaline rocks have up to the present been recorded from the following islands: Samoa, Rarotonga, Aitutaki, Mangaia, Raiatea, Huaheine, Mangareva, Pitcairn, Rurutu, and the Sandwich Islands.

The association of the rock types in Tahiti appears to have a close relationship to the series of alkaline and basic rock types at the Otago Peninsula, New Zealand. Here, as previously pointed out, there is a large area of white trachyte composed of almost pure feldspar, a large development of phonolites, and a great many basalts, as well as connecting types such as trachydolerites.* Some of the trachydolerites contain large crystals of brown hornblende which is largely resorbed, and is associated with the violet augite in exactly the same manner as in the theralites and essexites of Tahiti, and in similar rocks of other localities, such as Massachusetts. The composition of these trachydolerites is intermediate between the composition of the phonolites and that of the basalts.

At the north head of Otago Harbour a trachydolerite lava nearly always lies beneath a phonolite, which is in turn followed by basalts. The author has suggested that this association can be explained by the assumption that the lavas were supplied from a reservoir at an intermediate level, to which theralitic matter party crystallized was moved from time to time. Within this reservoir resorption of the crystals that had already formed might have taken place if the mineralizers of the magma escaped. Differentiation would then take place in this magma, with the result that phonolitic and basaltic matter might be separated and emitted at different eruptions.

Inspection of the old solidified plug of Tahiti shows that much differentiation of a magma can take place at depths of no more than 2,000 metres —in fact, that it may be so complete as to produce a syenite composed almost solely of feldspar as well as a non-feldspathic peridotite.

This observation may therefore explain the frequent association of alkaline and basic rock types in the Pacific region, to which attention has previously been called, and for which a special explanation has been required. "Whether the different species of rocks in Tahiti have resulted

* Marshall, P., "The Geology of Dunedin," Q.J.G.S., vol. 62, 1906, p. 388.

from magmatic differentiation is a question for the future. . . . The constant association of the main types in the islands visited truly supports this view."*

Interest largely centres in these oceanic islands in connection with the structure and origin of the Pacific basin. Many attempts have been made within recent years to establish an association between coastal structure and the products of volcanic activity, notably between the coast lands of the Pacific types of Suess and the occurrence of andesitic rocks. This idea has been supported by Harker and Prior, amongst others, while Gregory and others have dissented from it. Thus Lacroix points out that the andesitic type is strictly circum-Pacific. This statement holds in the present state of our knowledge, as pointed out by Marshall, if, as seems reasonable, Tonga, Fiji, New Hebrides, Santa Cruz, Solomon, Caroline, and Marianne Islands are considered as circum-Pacific in their situation, a suggestion which is strongly supported by ocean soundings.

On the other hand, those islands which are situated in the central areas of the Pacific Ocean are, so far as known, constituted of the alkaline and basic facies which are referred to the Atlantic region. It is, however, possible that the Marquesas (biotite trachyte, Lacroix) and Easter Island (andesites, Helsch) are exceptions. In order to explain this contrast between the andesitic border and the alkaline basic central area, the suggestion of Supan that andesitic rocks are the product of eruption where rock-folding is in progress, and alkaline basic rocks where radial fractures have been formed, demands attention. There is, however, so little knowledge of the actual structure of the basement on which these island groups are situated that any stated conclusions are more likely to be guesses or the expression of the personal bias of an author than scientific deductions based on reliable premises.

Other questions arise. Is the basin of the Pacific Ocean the scar left by the moon when it separated from the earth, an infallen area, or a depression of an isostatic nature due to the high specific gravity of the material of the earth's crust in that region? The study of the petrology of these island groups ought to produce some evidence on this point confirmatory or otherwise of such pendulum experiments that have been made.

I do not know whether the first theory should or should not require any particular nature of the rocks forming the floor and the material immediately beneath the floor of the ocean-basin. If there is, any one would perhaps expect the rock to be of an ultra-basic nature. If the area is infallen, it would be reasonable to expect to find occasional fragments of sediments included in the tuffs or lava-flows, as at Mount Ruapehu, New Zealand, as well as at Auckland and Dunedin. Search has, however, failed to reveal any such fragments in the islands of the Society and Cook Groups that I have visited. It would thus appear that sedimentary rocks form a less important part of the earth's crust in the neighbourhood than in the areas of the great volcanic districts of New Zealand.

On the other hand, there is in the volcanoes of these islands a great predominance of basic types of rock. In the basic rocks feldspar is relatively unimportant, and is in almost all cases confined to the groundmass. In the phonolites, which are, however, found in much smaller quantity than

* Marshall, P., "Handbuch der Regionalen Geologie," band vii, abt.2; also Rep. Aust. Ass. Sci., vol. 13, 1912, p. 201.

the basic rocks, feldspathoid minerals are often more abundant than the feldspars. Such facts as these, though possibly in the future they may require qualification or revision, suggest at least in the present state of our knowledge that the composition of sub-Pacific material is, on the whole, more basic than that of the other areas, and to that extent favours the idea of the isostatic equilibrium of the Pacific basin.

Summary.

1. The distribution of plutonic rocks in the Papenoo Valley, in the centre of Tahiti, is somewhat different from that stated in Lacroix' paper, which was based on the field-work of Seurat.

2. So far as the observations of the author showed, the outcrop of these rocks is almost confined to the low hill Ahititera, which occupies the centre of the large circular basin of the Upper Papenoo Valley.

3. The hill Ahititera is the centre of the island, and from the crest of the mountain rampart which surrounds the Upper Papenoo the level of the land falls outward somewhat evenly on all sides to the sea-level, though the slopes are deeply seamed by the stream-valleys which radiate outwards in large numbers.

4. The situation of Ahititera is therefore the position of the central conduit of the original great volcano of Tahiti.

5. The series of volcanic plutonic rocks discovered by Lacroix is extended by the discovery of a highly feldspathic syenite as well as a peridotite *in situ* in addition to some of the types already described as Lacroix.

6. This series is regarded as the result of the differentiation of an essexitic magma.

7. Parallels of these plutonic types are found in the dykes and the volcanic rocks found in the island.

8. It is suggested that the constantly occurring association of basic and alkaline volcanic rocks in other Pacific islands, and at Dunedin, New Zealand, has resulted in a similar manner.

9. No evidence was found in support of Daly's theory that the alkaline are due to the solution of calcium-carbonate rock by a basic magma.

10. It is suggested that the frequent highly basic character of the volcanic rocks of the Central Pacific islands supports the theory that the floor of the Pacific Ocean has its low-lying position as a result of isostatic equilibrium.

EXPLANATION OF PLATE VII.

Fig. 1. View of upper basin of Papenoo Valley, Tahiti, from Tetiari Pass (800 m.), looking south. Rounded conical hill in middle distance, Ahititera (850 m.), formed of plutonic rock. Tetufera Peak (1,800 m.) in background, in the centre.

Fig. 2. View of Orohe Peak from base of Ahititera Hill, Upper Papenoo Valley, Tahiti, looking north. Orohe Peak is formed of volcanic lava and breccia.

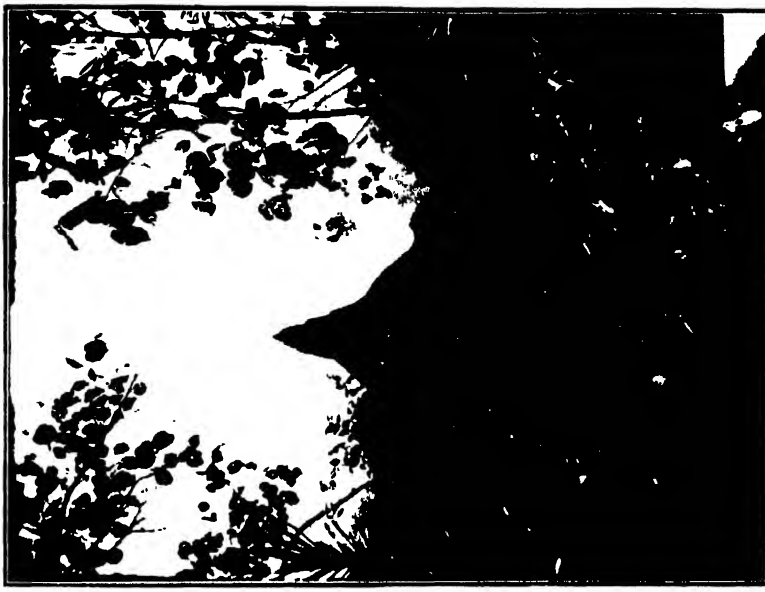


FIG. 2.—View of Orohe Peak. Upper Papenoo Valley.

TAHITI.

FIG pper Ba n of Papenoo ley.

PAPENOO

ART. XL.—*Cainozoic Fossils from Oamaru.*

By P. MARSHALL, M.A., D.Sc., F.G.S., Professor of Geology, Otago University.

[*Read before the Otago Institute, 1st December, 1914.*]

FURTHER collecting in the fossiliferous beds of Tertiary age near Oamaru has been continued on many occasions by Mr. Uttley and myself with several assistants. It has been thought worth while to put on record the names of those fossils that we have found, and to add to these lists stratigraphical and lithological notes of an explanatory nature. For the statements that are made here the author alone is responsible, but he is indebted to Mr. Uttley for much information.

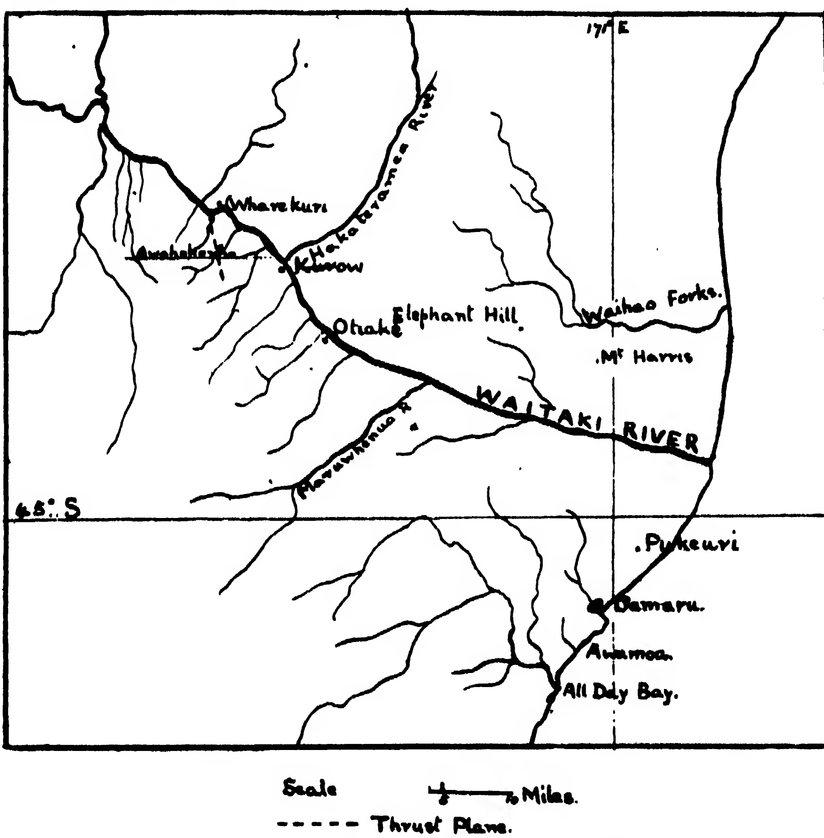


FIG. 1.—Sketch-map of Oamaru district, showing localities where fossils were collected.

The accompanying map shows the locality of the various places where we have made collections, and it will be seen generally that collections have been obtained from various points from All Day Bay, on the coast, ten miles south of Oamaru, to Wharekuri, in the Waitaki Valley, forty miles distant from the sea, and in the Waihao Valley, twenty miles to the north of Oamaru.

In the lists given here *Mollusca* only are classified. The Brachiopods of New Zealand are being separately reclassified by Dr. J. A. Thomson. The teeth of sharks are relatively few in this formation, and the Corals, *Foraminifera* and *Polyzoa* have not been separately collected. It is not supposed that the collections are exhaustive, though it is probable that relatively few species will hereafter be added to the list from Target Gully. The work of identification would have been impossible without the kind and generous assistance of Mr. H. Suter, who has also named a large number of the new species, and his descriptions of these will shortly be published in Bulletin No. 3 of the Palaeontological series of the New Zealand Geological Survey.

Target Gully.

Some three days have been spent at Target Gully, Oamaru, in adding to the collections previously made there. The following is a complete list, including the species that have been named by Suter. The description of these will be given in Bulletin No. 3 of the Palaeontological series of the New Zealand Geological Survey.

Schismope atkinsoni T.-Woods.
Emarginula striatula Q. & G.
Trochus tiaratus Q. & G.
Monilea simplex Suter.
Lissospira exigua Suter.
Circulus politus Suter.
Leptothyra fluctuata Hutton.
Cerithiopsis aequicincta Suter.
Newtoniella fidicula Suter.
Serpulorbis sp.
Turritella carlottae Watson.
—— *concava* Hutton.
—— *rosea* Q. & G.
—— *murrayana* Tate.
—— *patagonica* Sowerby.
Eglisia striolata Hutton.
Struthiolaria tuberculata Hutton.
—— *cincta* Hutton.
Calyptraea maculata Q. & G.
—— *alta* Hutton.
—— *maccoyi* Suter.
Crepidula crepidula L.
—— *densistriata* Suter.
—— *striata* Hutton.
—— *costata* Sowerby.
—— *incurva* Zittel.
Natica zelandica Q. & G.
Polinices suturalis Hutton.
—— *gibbosus* Hutton.
—— *cinctus* Hutton.
Cymatium minimum Hutton.
—— sp.
Epitonium browni Zittel.
—— *rugulosum lyratum* Zittel.
Turbonilla zelandica Hutton.
—— *oamarutica* Suter.
Odostomia pudica Suter.
—— *rugata* Hutton.
Fusinus sp.
Latirus brevirostris Hutton.
—— *elatior* Suter.
—— *compactus* Suter.
—— *acuticingulatus* Suter.
—— n. sp.
Mitra enysi Hutton.
Vexillum rutilidomum Hutton.
Siphonalia dilatata Q. & G.
—— *costata* Hutton.
—— *conoidea* Hutton.
—— *turrita* Suter.
—— *excelsa* Suter.
Euthria striophora Suter.
Cominella pulchra Suter.
—— *huttoni* Kobelt.
—— *intermedia* Suter.
Alectrion socialis Hutton.
—— *tatei* T.-Woods.
Murex octogonus Q. & G.
—— *angasi* Crosse.
Trophon lepidus Suter.
—— *paivae* Crosse.
Typhis maccoyi T.-Woods.
Admete praecursoria Suter.
Fulguraria arabica Martyn.
—— *elongata* Swainson.
—— *gracilis* Swainson.
—— n. sp.
Lapparia corrugata Hutton.
Ancilla australis Sowerby.
—— *pseudaustralis* Tate.
—— *bicolor* Gray.
—— *hebera* Hutton.

Marginella harrisi Cossman.
—— *conica* Harris.
Erato striata Suter.
Drillia imperfecta Suter.
—— *callimorpha* Suter.
Surcula fusiformis Hutton.
—— *awamoaensis* Hutton.
Bathytoma sulcata Hutton.
— *anticostata* Suter.
—— *perlata* Suter.
Turris altus Harris.
—— —— *transennus* Suter.
Mangilia brachyspira Suter.
—— *infelix* Suter.
—— *canaliculatus* Suter.
—— *tenuilirata* Suter.
—— *leptosoma* Suter.
—— *rudis* Hutton.
—— *sinclairi* Smith.
Terebra orycta Suter.
—— *costata* Hutton.
Ringicula uniplicata Hutton.
Cylichnella enysi Hutton.
—— *striata* Hutton.
—— *soror* Suter.
Volvulella reflexa Hutton.
Hemiconus traillí Hutton.
Dentalium solidum Hutton.
—— *mantelli* Hutton.
—— *nanum* Hutton.
Nucula hartvigiana Phil.
Malletia australis Q. & G.
Anomia huttoni Suter.
Placunanomia incisura Hutton.
—— *zelandica* Gray.
Arca decussata Gray.
—— *australis* Hutton.
—— *subvelata* Suter.
Glycymeris laticostata Q. & G.
—— *globosa* Hutton.
Cucullaea alta Sowerby.
Limopsis zitteli Ihering.
—— *catenata* Suter.
Pecten radius Hutton.
—— *burnetti* Hutton.
—— *huttoni* Park.
Lima colorata Hutton.
—— *bullata* Born.
Mytilus striatus Hutton.
Ostraea angasi Hutton.
—— *nelsoniana* Zittel.
Crassatellites obesus A. Adams.
—— *attenuatus* Hutton.
—— *amplus* Zittel.
Venericardia difficilis Deshayes.
—— *pseutes* Suter.
Diplodonta globularis Lamarck.
Loripes laminata Hutton.
Divaricella cumingi Adams and Angas.
Tellina glabrella Deshayes.
Zenatia acinaces Q. & G.
Dosinia magna Hutton.
—— *greyi* Zittel.
Macrocallista multistriata Sowerby.
Chione meridionalis Sowerby.
—— *mesodesma* Q. & G.
—— *yatei* Gray.
Paphia curta Hutton.
—— n. sp.
Cytherea oblonga Hanley.
—— *sulcata* Hutton.
—— *subsulcata* Suter.
Cardium patulum Hutton.
—— n. sp.
Psammobia lineolata Gray.
Corbula pumila Hutton.
—— *canaliculata* Hutton.
—— *humerosa* Hutton.
—— *caiparaensis* Suter.
Panopaea sp.
Myodora subrostata E. A. Smith
Chamostraea albida Lamarck.
Chama huttoni Hector.
Teredo heaphyi Zittel.

Additional species since obtained are—

Hinnites trailli Hutton.
Protocardia sera Hutton.
Trivia n. sp.
Mitra n. sp.

The total number of species in this list is 155, of which forty-seven species are Recent—a percentage of 33. The collections that we have made at Target Gully illustrate forcibly the errors that are likely to arise if, for the purpose of classifying strata, importance is laid on the absence of species or genera of fossils found in incomplete collections which may be used to

arrange the Cainozoic formations of New Zealand in a chronological sequence. Thus the first year's collecting in these beds gave us no *Epitonium*, *Cardium*, *Paphia*, *Fusinus*, or *Mangilia;* while *Murex*, *Latirus*, and *Struthiolaria* were poorly represented.

The present list appears to be sufficiently complete to establish a definite horizon, which stratigraphically lies almost directly on the Hutchinson's Quarry beds, which in its turn admittedly rests on the Oamaru limestone. The fauna appears to be characteristic of a depth of about 40 fathoms. The incomplete filling of many of the larger shells with sediment, and the uninjured nature of such shells as *Murex*, show that the sea-floor was not subject to much disturbance. The fact that many shells are broken must probably be ascribed to fish. The grains of glauconite, which are quite frequent, point to slow accumulation and an extensive shore-line situated many miles away.

The number of species of *Mollusca* collected in this small shell-bed, 4 ft. high and 6 ft. long, is more than one-seventh part of the number of the Recent species of New Zealand *Mollusca* recorded in Cheeseman's Manual.

Wharekuri.

The locality from which we have collected at Wharekuri is on the bed of the Waitaki River, about forty miles from the sea. The actual spot is about one mile below Wharekuri, and on the opposite (or left) bank of the river. Lithologically the beds consist of a marly greensand, and dip about 2° to the north. There can be no doubt that they directly overlie the *Kekenodon* beds of McKay, classed by him with the Upper Eocene.* They are, in fact, identical with the fossiliferous horizon on the opposite bank of the river, referred to by McKay.

Hamilton subsequently showed that in the extreme southern portion of this Tertiary basin the rocks are cut by several fault-planes.† From the *Kekenodon* beds of McKay Hamilton obtained a good specimen of *Aturia ziczac* var. *australis*.

Park classed these strata as the equivalent of the Mount Brown beds, the middle member of his Miocene system.‡ The whole series of Cainozoic beds is certainly conformable, as shown by Park, though the large fault inserted by him is unnecessary.

In the Wharekuri basin the lowest rocks of the Tertiary sequence are quartz gravels, a fact that has considerable significance. The quartz is undoubtedly derived from schist, and the area of schist rocks is now separated from the Waitaki Valley by Mount Domett and the Kakanui Ranges, with an average elevation of about 4,000 ft.

The occurrence of the quartz gravels, therefore, practically proves that the range of the Kakanui Mountains did not then exist, for in such a narrow fiord as the present Waitaki Valley would have been if the Kakanui Range had then existed the floor must have been covered with detritus derived from the slopes of the neighbouring range—that is, with material derived from the waste of greywacke rocks—a deposit that is quite common in New Zealand, and quite different from the nearly pure quartz gravels of which the lowest Tertiary rocks are composed.

* Rep. Geol. Surv., 1881, p. 67.
† Trans. N.Z. Inst., vol. 36, 1904, p. 465.
‡ Trans. N.Z. Inst., vol. 37, 1905, p. 525.

In the floor of the Awahokomo Valley, about three miles from the point where it joins the Waitaki, the junction of the Tertiary strata with the Maitai rocks of which the Kakanui Mountains are formed is to be clearly seen. The actual plane of junction dips 73° to the south, and strikes 15° west of north. The Maitai rocks to the south of the plane of junction are greatly shattered. This is best seen when the line is followed over the hills which lie to the north of the Awahokomo. The weathering of the rocks has here developed their shattered nature, and they break down into a clayey material, which still contains angular fragments of rock. This shattered material has been called by McKay "glacier deposits." *

There can be no doubt that this plane of junction is a thrust-plane, though more highly inclined than is usual for such planes. This high inclination of a thrust-plane appears to be a feature of those examples that have been described in New Zealand.†

In the present case the great tectonic movement has had relatively little effect on the Cainozoic sediments over which the Maitai rocks have been thrust. These are in no way crushed, and the fossils which are contained in them are not distorted. This again appears to be a feature of New Zealand Tertiaries when they are involved in tectonic movements. The fossils in the narrow band of Tertiary rocks, only 15 ft. wide, at Stony Creek, near Lake Wakatipu, with schist on both sides of it, are not distorted, and again the rock is not crushed. In the Clarence Valley the rocks are not fossiliferous, but their structure does not appear to have suffered in any way by the great tectonic movements which have been so well described by Cotton.

On the northern bank of the river the beds soon rise gradually, and before long the basal quartz gravels with coal-seams are exposed. They contain good specimens of fossil wood similar to that described by Unger as Nicolia.‡

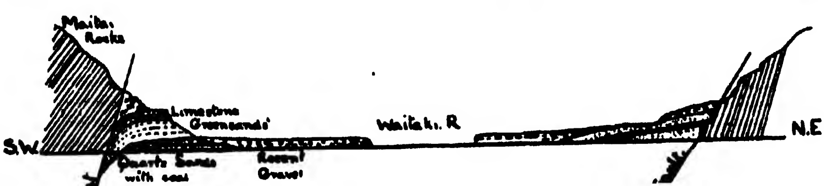


FIG. 2.—Section across Wharekuri Basin.

Away from the river the ground rises somewhat more steeply, and highly siliceous greensands are seen to rest on the quartz gravels. These greensands contain *Cucullaea*, *Venericardia*, *Dentalium*, and *Natica* rather badly preserved, but apparently similar to the species that were found in the river-bank. In the Awahokomo Valley the same genera were found in a greensand lying only 20 ft. above the quartz gravels, which there contain coal-seams. There is obviously every reason to believe that the whole of the younger rocks in the Wharekuri Basin belong to the same series.

On the north-east side of this basin of Tertiary rocks the Maitai sediments rise abruptly in a steep scarp for about 1,000 ft., and this scarp is but little incised by the erosion of the streams that flow down it. The outcrop is separated from that of the Tertiary rocks by a distance of about 30 ft. only,

* Rep. N.Z. Geol. Surv., 1881, p. 60.
† Cotton, Geogr. Mag., 1913, p. 227.
‡ "Reise der 'Novara,'" 1865 Geologischer Theil, Band 1 p. 13.

and the two series appear to be separated from one another by a normal fault. The diagram, fig. 2, therefore represents the author's opinion of the structure of this interesting basin of Tertiary rocks.

The following is a list of the fossils found in the marly greensands on the left bank of the river about a mile below Wharekuri, which were obtained as a result of two days' collecting :—

Turritella ambulacrum Sowerby.
—— *pagoda* Reeve.
—— *symmetrica* Hutton.
—— *carlottae* Watson.
Struthiolaria cincta Hutton.
Calyptraea maculata Q. & G.
Polinices gibbosus Hutton.
—— *huttoni* Ihering.
—— *cinctus* Hutton.
—— *suturalis* Hutton.
Cymatium minimum Hutton.
Epitonium rugulosum lyratum Zittel.
—— n. sp.
Niso n. sp.
Fusinus sp.
Siphonalia nodosa Martyn.
—— *excelsa* Suter.
Cominella exsculpta Suter.
—— *pulchra* Suter.
Alectrion socialis Hutt.
Lapparia corrugata Hutton.
Fulguraria gracilis Swainson.
Ancilla pseudaustralis Tate.
—— *bicolorata* Hutton.
Marginella harrisi Cossman.
Turris uttleyi Suter.
Drillia callimorpha Suter.
Surcula fusiformis Hutton.
—— *hamiltoni* Hutton.
Bathytoma sulcata excavata Suter.
Mangilia cincta Hutton.
—— *rudis* Hutton.
Exilia dalli Suter.
Cylichnella enysi Hutton.
Xenophora sp.
Dentalium mantelli Zittel.
—— *solidum* Hutton.
Leda semiteres Hutton.
—— *bellula* A. Adams.
Malletia australis Q. & G.
Anomia trigonopsis Hutton.
—— *walteri* Hutton.
Glycymeris cordata Hutton.
Cucullaea attenuata Hutton.
Limopsis aurita Brocchi.
—— *zitteli* Ihering.
Pecten chathamensis Hutton.
—— *huttoni* Park.
Ostraea tatei Suter.
Crassatellites obesus A. Adams.
Venericardia pseutes Suter.
Loripes laminata Hutton.
Dosinia greyi Zittel
Macrocallista multistriata Sowerby.
Chione meridionalis Sowerby.
Cardium patulum Hutton.
Psammobia lineolata Gray.
Corbula humerosa Hutton.
—— *canaliculata* Hutton.
Teredo heaphyi Zittel.

Fourteen species in this list of sixty are Recent, a percentage of 23·3. The most abundant of these fossils are *Polinices huttoni*, *Cucullaea attenuata*, *Venericardia pseutes*, *Crassatellites obesus*, and amongst the smaller shells *Limopsis zitteli*.

The only other list of species of *Mollusca* from this locality is that given by Park.* Park's collection, however, was made on the other side of the river. It contains thirty-nine species, of which only twelve are identical with the species listed here.

Otiake.

There is a prominent exposure of limestone on the right bank of the Waitaki, about five miles below Kurow. It lies half a mile distant from the railway-line between Oamaru and Kurow, on its southern side, just below

* Trans. N.Z. Inst., vol. 37, 1905, p. 525.

the bridge over the Otiake Stream. The limestone is of an arenaceous nature, and contains a great number of fossils. Near its base there is a thin band of greensand, which contains many specimens of *Isis dactyla*, *Magellania* sp., and *Pecten huttoni*.

The following is a list of the species obtained during two days' collecting from a face of arenaceous limestone some 50 ft. in height:—

Turritella cavershamensis Harris.
—— *murrayana* Tate.
Struthiolaria vermis Martyn.
Crepidula gregaria Sowerby.
—— *striata* Hutton.
Calyptraea maculata Q. & G.
Natica zelandica Q. & G.
Polinices huttoni Ihering.
—— *suturalis* Hutton.
—— *cinctus* Hutton.
—— *gibbosus* Hutton.
Trichotropis clathrata Sowerby.
Epitonium rugulosum lyratum Zittel.
Fusinus sp.
Mitra n. sp.
Siphonalia conoidea Zittel.
—— *nodosa* Martyn.
Cominella pulchra Suter.
Murex zelandicus Q. & G.
Typhis maccoyi T.-Woods.
Fulguraria gracilis Swainson.
Lapparia corrugata Hutton.
Ancilla hebera Hutton.
—— *bicolorata* Gray.
—— *mucronata* Sowerby.
Marginella harrisi Cossman.
Turris altus Harris.
—— *altus transennus* Suter.
uttleyi Suter.
Exilia dalli Suter.
—— n. sp.
Terebra orycta Suter.
Surcula n. sp.
—— n. sp.
Drillia callimorpha Suter.
Bathytoma sulcata excavata Suter.
Euthria sp.
Mangilia rudis Hutton.
—— *tenuilirata* Suter.
—— n. sp.
Dentalium solidum Hutton.
—— *mantelli* Zittel.
Cucullaea attenuata Hutton.
Limopsis aurita Brocchi.
Modiolus australis Gray.
Pecten zelandiae Gray.
—— *huttoni* Park.
Lima colorata Hutton.
Crassatellitus obesus A. Adams.
Venericardia difficilis Deshayes.
Divaricella cumingi Adams and Angas.
Zenatia acinaces Q. & G.
Dosinia greyi Zittel.
Cytherea oblonga Hanley.
—— n. sp.
Macrocallista multistriata Sowerby.
—— *assimilis* Hutton.
Corbula canaliculata Hutton.
—— *humerosa* Hutton.
—— *caiparaensis* Suter.
Teredo heaphyi Zittel.

This list contains sixty-one species, of which fifteen are Recent, a percentage of 24. No collecting has previously been done in this locality.

ALL DAY BAY.

In this locality the lowest rock is a volcanic breccia commonly known in New Zealand geology as the Waireka tuffs. A bed of limestone about 12 ft. thick rests on the breccia quite conformably. The upper surface of the limestone is remarkable for the abundant remains of species of *Isis*. This upper surface is somewhat uneven, as is generally the case in New Zealand when the limestone is succeeded by a bed of greensand, which is the case here. The greensands gradually become argillaceous, and within a thickness of 50 ft. they pass into a material that cannot be distinguished from the Awamoa beds, which five miles farther north are clearly seen at the Rifle Butts to have exactly the same stratigraphical position. No lists of fossils from this locality have been published previously. The

following twenty-seven species were found by us in the course of one day's collecting :—

Turritella cavershamensis Harris.
Polinices gibbosus Hutton.
Cymatium n. sp.
Phalium achatinum pyrum Lamarck.
Epitonium browni Zittel.
Turbonilla oamarutica Suter.
Mitra n. sp.
Vexillum apicale Hutton.
Typhis maccoyi Tate.
Murex octogonus Q. & G.
Lapparia corrugata Hutton.
Ancilla bicolorata Gray.
—— n. sp.
Marginella conica Harris.
Marginella harrisi Cossman.
Turris altus Harris.
Mangilia rudis Hutton.
Dentalium mantelli Hutton.
Placunanomia zelandica Gray.
Limopsis zitelli Ihering.
Nucula hartvigiana Phil.
Pecten huttoni Park.
Lima colorata Hutton.
Crassatellites obesus A. Adams.
Venericardia australis Lamarck.
Macrocallista assimilis Hutton.
Corbula pumila Hutton.

Only six of these twenty-seven species are known to be Recent, a percentage of 22·2. As stated previously, the beds at All Day Bay are similar stratigraphically and lithologically to the Awamoa beds, but in a collection of sixty-four species made at Awamoa in 1912 the percentage of Recent species was found to be as high as 35·5.

Rifle Butts.

At this locality, which is situated a short distance to the south of Cape Wanbrow, the strata are dipping to the south at an angle of 35°. The sequence is here perfectly plain, and the highest beds are composed of bluish clay similar to that at Awamoa and All Day Bay. In descending order, these are succeeded by greensands, limestone, and tuffs. Here, as at many other places near Oamaru, the continuous deposition has been greatly interrupted by the volcanic eruptions of the vicinity, which have caused beds of tuff to be associated with the blue clay. Collections of *Mollusca* were made from the blue clay, with the following result :—

Turritella patagonica Sowerby.
—— *concava* Hutton.
—— *sturtii* Tate.
—— n. sp.
Crepidula gregaria Sowerby.
Natica zelandica Q. & G.
Polinices suturalis Hutton.
—— *gibbosus* Hutton.
—— *amphialus* Watson.
Turbonilla oamarutica Suter.
Phalium achatinum pyrum Lamarck.
Vexillum apicale Hutton.
—— *linctum* Hutton.
Siphonalia turrita Suter.
Alectrion socialis Hutton.
Ancilla bicolor Gray.
Marginella pygmaea Hutton.
—— *conica* Harris.
Marginella harrisi Cossman.
Turris altus Harris.
Drillia awamoaensis Hutton.
Surcula fusiformis Hutton.
—— n. sp.
Bathytoma albula Hutton.
Mangilia rudis Hutton.
—— *protensa* Hutton.
—— *leptosoma* Hutton.
Cylichnella thetidis Hedley.
Dentalium solidum Hutton.
Placunanomia zelandica Gray.
Cucullaea attenuata Hutton.
Pecten scandulus Hutton.
Venericardia difficilis Deshayes
Loripes laminata Hutton.
Tellina glabrella Deshayes.
Zenatia acinaces Q. & G.
Cytherea oblonga Hanley.
Corbula canaliculata Hutton.

Of these thirty-eight species, only ten are Recent—that is, a percentage of 26·3.

MAEREWHENUA RIVER.

A small collection was made by Mr. Uttley near the right bank of this river, ten miles distant from the point where it joins the Waitaki. The rock in which the fossils are embedded is a limestone. The following species have been identified :—

Turritella carlottae Watson.
Capulus australis Lamarck.
Polinices amphialus Watson.
Sinum n. sp.
Ancilla bicolor Gray.
Surcula n. sp.
Mangilia n. sp.
Cylichnella enysi Hutton.
Nucula stangei A. Adams.
Venericardia difficilis Deshayes.
Cardium waitakiense Suter.
—— n. sp.
Corbula humerosa Hutton.

WAIHAO VALLEY.

In this district Mr. Uttley made collections at several different localities, as shown below.

1. Right bank of the Waihao River, three miles below the Waihao Forks, in a bed of greensands which lies conformably below the arenaceous limestone. Ten per cent. of the species are Recent.

Turritella concava Hutton.
—— *murrayana* Tate.
—— *carlottae* Watson.
—— *patagonica* Sowerby.
Struthiolaria papulosa Martyn.
Polinices suturalis Hutton.
Galeodea senex Hutton.
Alectrion socialis Hutton.
Lapparia corrugata Hutton.
Ancilla hebera Hutton.
Surcula fusiformis Hutton.
—— n. sp.
—— n. sp.
Bathytoma haasti Hutton.
*Hemiconus traill*i Hutton.
Dentalium mantelli Zittel.
Limopsis aurita Brocchi.
Lima paucisulcata Hutton.
Crassatellites obesus A. Adams.
Corbula paucisulcata Hutton.

2. Right bank of the Waihao River, at McCulloch's bridge. Here again the fossil-bearing beds consist of greensand which lies conformably beneath the arenaceous limestone. Fifteen per cent. of the species are Recent.

Turritella aldingae Tate.
—— *ambulacrum* Sowerby.
Natica zelandica Q. & G.
Polinices suturalis Hutton.
Mitra inconspicua Hutton.
Siphonalia turrita Suter.
Ancilla bicolor Gray.
Turris n. sp.
—— n. sp.
Surcula pareorensis Suter.
Mangilia rudis Hutton.
Dentalium solidum Hutton.
Corbula canaliculata Hutton.

3. Near Mount Harris, on the slope towards the Waitaki Valley—the first outcrop on the road leading from the Waitaki to the Waihao Valley.

Turritella murrayana Tate.
—— *cavershamensis* Harris.
—— *concava* Hutton.
Polinices gibbosus Hutton.
Galeodea senex Hutton.
Epitonium browni Zittel.
Ancilla browni Zittel.
—— *bicolor* Gray.
Drillia n. sp.
Surcula fusiformis Hutton.
Dentalium mantelli Zittel.
Nucula n. sp.
Malletia australis Q. & G.
Limopsis aurita Brocchi.
Crassatellites obesus A. Adams.
Venericardia difficilis Deshayes.
Zenatia acinaces Q. & G.
Cytherea oblonga Hanley.
Psammobia lineolata Gray.
Corbula oaiparaensis Suter.
—— *canaliculata* Hutton.
humerosa Hutton.

The fossils are contained in a stratum of brown sands, which is the material of which Mount Harris is formed. This material overlies the limestone, and is probably a slightly higher horizon than that of the Target Gully beds. Thirty-three per cent. of the species are Recent.

4. The top of the hill from Waihao Forks to the Elephant Hill. The rocks here again are brown sands similar to those of the last locality.

Turritella cavershamensis Harris.
—— *carlottae* Watson.
Natica zelandica Q. & G.
Polinices suturalis Hutton.
—— *huttoni* Ihering.
Fusinus n. sp.
Siphonalia conoidea Zittel.
Alectrion socialis Hutton.
Fulguraria arabica Martyn.
Ancilla bicolor Gray.
Marginella pygmaea Sowerby.
Surcula fusiformis Hutton.
Surcula n. sp.
—— n. sp.
Bathytoma sulcata excavata Suter.
Mangilia n. sp.
Terebra costata Hutton.
Cylichnella thetidis Hedley.
Thalassohelix igniflua Reeve.
Dentalium nanum Hutton.
—— *ecostatum* T. W. Kirk.
Crassatellites obesus A. Adams.
Venericardia difficilis Deshayes.
Corbula canaliculata Hutton.

Of these species, as many as 46 per cent. are Recent.

The general similarity of these lists at once establishes the fact that the rocks in which the fossils occur belong to the same stratigraphical series. This fact is also, in the author's opinion, abundantly proved by the stratigraphical evidence, for no appearance of a stratigraphical break is to be found. Hector and McKay, however, placed these strata in three different formations—Cretaceo-tertiary, Upper Eocene, and Lower Miocene; Hutton placed them partly in the Oligocene and partly in the Miocene; while Park classified them all in the Miocene formation. It is obvious from the foregoing lists that the last opinion is probably correct, though the author differs from Park as to the arrangement of the different beds within this system. The stratigraphical sequence is clearly—

4. Brown sands.
3. Grey argillaceous beds (Awamoa).
2. Limestone.
1. Greensands.

That this arrangement is supported by the palaeontological evidence is shown by the following considerations: The greensands at Wharekuri contain 23·3 per cent. of Recent species, and those on the Waihao 10 per cent. and 15 per cent. respectively. The lower percentages in the last two cases are based on small and probably quite incomplete collections.

Collections were made from the limestone at Otiake. In this place it has a molluscan fauna which contains 24·2 per cent. of Recent species. Though the limestone has a wide occurrence in the Oamaru district, it seldom contains many molluscan remains, and in most localities the hard and compact nature of the rock makes it almost impossible to extract the shells. In those places only where the limestone is highly arenaceous can the shells be collected with any ease. Park has classified the limestone outcrops at Oamaru in two different series, but we are not able to agree with this from a study of the stratigraphical evidence. The palaeontological evidence as here detailed gives no support to this theory. The fauna of the greensands at Wharekuri and at Waihao appears to be of a distinctly more ancient type than that of the sands which rest on the limestone at Oamaru. Park

would consider these two strata of the same age. The Oamaru limestone generally consists almost entirely of remains of Echinoderms, *Polyzoa*, and *Foraminifera*, though the material is generally somewhat fragmentary.

Near the coast at Awamoa, and actually on the coast at the Rifle Butts and at All Day Bay, the rocks which rest on the limestone are a bluish-grey calcareous mudstone. The percentage of Recent species contained in the *Mollusca* found in these rocks is 35, 26, and 22 respectively. The divergence between these results is considerable, but the collections are of very different values. It is possible that when the collections are more complete the results will be more in accord.

The Target Gully beds are a slightly higher horizon, and the large collection that has been made there contains 33 per cent. of Recent species. The beds of Mount Harris, in rather similar material, give almost the same result; while those of Elephant Hill, which appear to be a still higher horizon, contain as much as 46 per cent. of Recent species.

Thus the relative number of Recent species gradually becomes greater in the higher beds, as would, indeed, be expected; and it is evident that this result, at the least, strongly supports the conclusion as to the relative position of the strata which was dependent upon purely stratigraphical observations.

As to the actual percentages of Recent species, it is probable that considerable changes will be made in the future as the molluscan fauna of the deeper waters off the New Zealand coasts becomes better known. At the present time relatively little dredging has been done, and it cannot be doubted that several species hitherto believed to be extinct will be yet discovered when further work of that nature has been done. It is, however, evident that none of the strata from which the collections described in this paper have been made is older than the Miocene period. This statement, however, involves the question whether any importance is to be attached to the percentage of Recent species. In a country so geographically isolated as New Zealand it is possible that formal change is very slow and that a relatively high percentage of Recent species may be found in strata of relatively high antiquity.

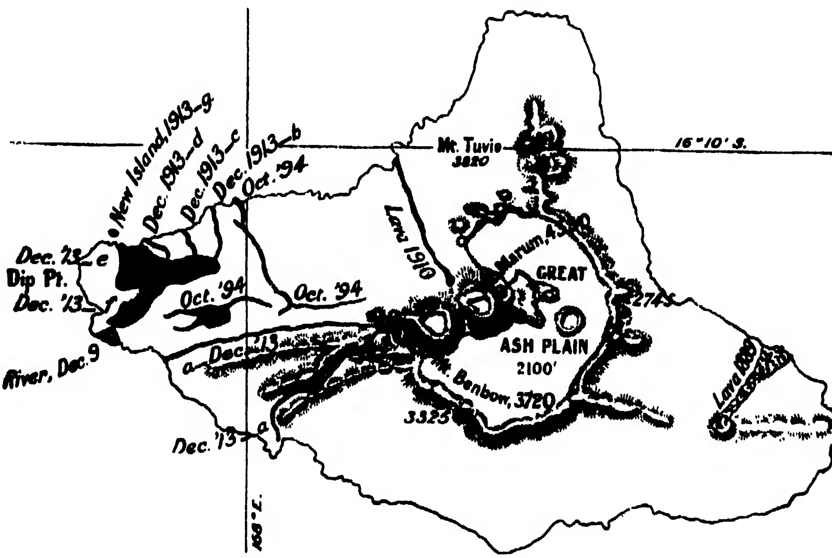
ART. XLI.—*The Recent Volcanic Eruptions on Ambrym Island.*

By P. MARSHALL, M.A., D.Sc., F.G.S., Professor of Geology, Otago University.

[*Read before the Otago Institute, 1st December, 1914.*]

IT is well known that geologically the New Hebrides Islands are mainly of volcanic origin, and of all of them Ambrym Island is the best known because of its volcanic activity. The island is near the middle of the group, in latitude 16° 10′ S. and longitude 168° E. It is more or less triangular in shape, with its greater dimension extending for thirty miles in a direction that is nearly east and west. It measures twenty-one miles in a north-to-south direction. Its surface is mountainous, the highest point, Mount Marum, rising to 4,380 ft., while the whole of the central portion of the island rises to more than 2,000 ft. Volcanic activity was in progress on the island when it was first sighted by Captain Cook, in 1774, and its activity has been frequently mentioned by travellers since that date.

The best description of the island is that given by Captain Purey Cust.* Whilst he was surveying the island in H.M.S. "Dart" in 1894 he witnessed an eruption of great magnitude. Captain Purey Cust describes a great central ash plain, as much as five or six miles in diameter, in the more elevated part of the island. On the edge of this, on its western side, are situated the two volcanoes Marum and Benbow, 4,380 ft. and 3,720 ft. respectively. The latter of these was active at the time of Purey Cust's visit, though the activity that took place in the crater of the volcano was explosive only, for the lava-streams which were emitted at that time escaped from orifices two to five miles to the west of the volcano. One of these streams flowed north-west and then north, finally reaching the coast at Krong Point after flowing for a distance of six miles. Another stream, which flowed from a point farther to the west, filled a small lake. The former of these streams is said to be no more than 10 yards wide in places.



SKETCH-MAP OF AMBRYM ISLAND.

There was a small eruption near the extreme east of the island in 1889. In 1910 a lava-stream issued from near the base of Mount Marum, and flowed in a N.N.W. direction, finally reaching the sea at a point about five miles distant from its point of origin.

Dr. Bowie has kindly given me the following account of the devastating eruptions of December, 1913, which were almost confined to the extreme western end of the island.

Some of the essential features of the island are shown in the appended map, which has been copied from that of Captain Purey Cust. On this map Dr. Bowie has kindly indicated the direction of the lava-flows of 1910, 1913, and 1914. A few of the surface features of the island are indicated in the accompanying sketch-map, but in order to obtain a good idea of its topography it is necessary to consult the map of Captain Purey Cust.

* Journ. & Proc. Roy. Geog. Soc., 1896, p. 586.

It appears tolerably evident that the central ash plain marks the site of a former large cone which was truncated by an immense explosive eruption, though Mawson refers to it merely as an old crater.

REPORT OF ERUPTION IN AMBRYM ISLAND, NEW HEBRIDES, 7TH DECEMBER, 1913, BY DR. BOWIE.

On the 6th December, 1913, a little after 5 p.m. it was observed that Mount Benbow, Ambrym Island, was in active eruption to an exceptional degree. Gigantic columns of steam were seen to rise many thousands of feet in the air. After each explosion a fresh pillar could be made out, boring its way in a spiral fashion through the cloud which extended upwards from the mouth of the crater. The succeeding explosions followed each other in more and more rapid succession, as well as in added force, until within an hour the intervals between the explosions were reduced from about three minutes to under one minute, and ultimately there was apparently no interval at all.

(*a*.) Just before dark, dense columns of steam and smoke were observed rising somewhere in the western edge of the "Great Ash Plain," and as darkness fell we could easily see a great river of incandescent lava rushing towards Baulap; another was running towards Port Vato. We climbed the hill immediately behind the hospital at Dip Point, and watched the Baulap stream until it reached the sea, which it did a little after 9 p.m. Lava, however, continued to flow down that valley for at least a whole day after this.

(*b*.) About 11 p.m. a new lava-stream was sighted rushing down the hillside about three miles and a half north-east along the coast. It reached the sea immediately to the west of Krong Point at about 2 a.m.

(*c*.) Soon after the last stream reached the sea it became very apparent that another lava-flow was on its way to the sea. During the whole night the sky was brilliantly lit up, but now, though there were high hills between us and the various rivers of lava, the valley in which we were was so illuminated that we could discern objects hundreds of yards away. This stream reached the sea two miles to the north-east of the hospital about 2.30 a.m., 7th December.

(*d*.) Almost simultaneously with stream (*c*) another made its appearance back in the hills at the head of Lowea Valley. This stream, one could easily observe, was coming much nearer to us, and we calculated the speed of the flow at about five miles an hour. Certainly the incline was, on the whole, pretty steep, and at one place the lava poured over a precipice about 60 ft. or 70 ft. high. The sight was magnificent as well as awe-inspiring. The lava, which was quite incandescent, came quickly on, burning up great forest-trees, tossing them all aglow in the air. As they fell again into the torrent they rebounded high in the air, emitting sparks like a thousand catherine-wheels. Soon after 3 a.m. the lava plunged with a savage hiss and a mighty roar into the sea. The sight was then superb, and never to be forgotten.

The din as the lava flowed through the forest reminded one very much of the noise of a hurricane with the boom of the ocean and the crashing of great forest-trees.

The last stream mentioned reached the sea within three-quarters of a mile of the hospital compound, but the hospital was built in a valley surrounded by hills except on the sea side. The valley behind was about a mile and a half long by about a mile broad at its widest part, and narrow-

ing to within half a mile at the sea. The hills around ranged from 500 ft. to 1,245 ft., and we considered everything inside this barrier as being quite safe.

Just about the time, or shortly before, the last stream reached the sea we saw a dense volume of black smoke rising from the hilltop on the east side, near the entrance to the valley and overlooking the hospital. When day broke we discovered the top of the hill was being blown out, but as yet there was no appearance of fire; only some continuous expulsive force was driving the hilltop out. There were no separate explosions observable. The force was continuous. Soon, however, fire appeared, and the force increased quickly, so that one could observe the hill steadily diminishing in height. The side of the hill looking west was acted upon, and decreased more quickly than the other sides, and about 10 a.m. on the 7th lava began to flow down the hillside into the valley and through part of the hospital compound.

(*e*.) The ground in the valley could be felt in motion—a kind of heave—not violently, but reminding one of a slight motion at sea. This motion was not continuous, but at very short intervals.

Shortly after 10 a.m. an explosive eruption blew the hospital and other buildings into the air. The force of this explosion was terrific. First a great sheet of what appeared to be electric flame flashed from the ground, and immediately following was a mighty roar and crash like myriad thunder-claps one piled on another. The heat, too, was intense. We could see for an instant only the corrugated iron spreading out like scintillating glass, and then it was gone. Explosion then followed explosion almost continuously for four days at least. Sometimes there would be a short interval, but the intervals did not last long.

(*f*.) We discovered at daylight that another lava-stream had flowed behind our hills towards Craig's Cove. This stream stopped on the plain about 500 yards from the beach. This stream was the biggest of all, being in some parts about three-quarters of a mile wide.

(*g*.) About 3 p.m. on the 7th a submarine volcano broke out about a mile from the shore off Lamb Point. Soon an island was formed, and within sixteen hours had joined the mainland. After four days the activity of this volcano ceased.

On Tuesday, the 9th December, a geyser suddenly broke out a few hundred yards inland from Craig Point. Water must have been forced to a considerable height, for we were drenched in a mud bath while over 500 yards from the shore. The geyser lasted for probably fifteen minutes or more. Immediately after the geyser ceased a roar like a rushing torrent was heard. Very soon a river extending in width from the trading-station at Craig Point to Malver tore its mad rush to the sea. For half an hour or so there was a great volume of water, which gradually diminished in volume, and apparently in speed. This river ran for at least six hours.

On Sunday, the 7th December, there were six distinct craters in the vicinity of Dip Point, West Ambrym. The whole district was undoubtedly a fairly recent volcanic area. In the valley behind the hospital, as well as at Craig's Cove, outcrops of lava could be seen at various points, and there was little evidence of weathering, the lava in many places appearing rugged, as it does soon after cooling.

Petrography.

The rocks of Ambrym do not appear to have been described hitherto, and it has therefore been thought advisable to add to this account of the eruption by Dr. Bowie a few notes on the rock-specimens that have been

brought from this island. Some of these have been kindly forwarded by the Rev. Peter Milne, a missionary on Nguna Island, and others by Professor W. Morris Davis.

The locality of the specimens sent by Mr. Milne is not stated, but Dr. Bowie assures me that the rock is the commonest type that is found at the western end of the island. This rock is highly vesicular, and contains large rounded phenocrysts of feldspar as much as 1 cm. in diameter, but no other minerals can be distinguished in hand-specimens.

In section the rounded crystals of feldspar are found to be aggregates of bytownite, with an extincton-angle of 40° in those sections which are at right angles to the brachypinacoid. In the central portions of these aggregates there are a great many inclusions of magnetite and of glassy matter. These can be compared with the feldspar glomerules of the Mau basalt previously described by Mawson.* In the present instance, however, there is not a marginal zone of inclusions, nor are the marginal portions less basic than the central area. Smaller crystals of greenish augite and of perfectly colourless olivine also occur, and in some instances rounded grains of olivine are actually embedded in the feldspar. The groundmass consists almost equally of microlites of bytownite, short crystals but more frequently rounded grains of augite, and sometimes also of olivine. There is a considerable residue of brownish glass, densely filled with magnetite-dust.

From Dip Point Professor W. M. Davis has sent me a specimen of a compact grey rock which contains numerous feldspar phenocrysts. As in the previous case, the phenocrysts when examined with the microscope are found to be aggregates of several crystals, though they are less regularly arranged than in the preceding rock. The mineral in these aggregates is again bytownite. The groundmass consists mainly of bytownite with large grains of diopside and of colourless olivine, and small octahedrons of magnetite. There is a base of brownish glass, which contains numerous needles of ilmenite.

A specimen of the lava of 1913 at Dip Point was also sent to me by Professor W. M. Davis. The hand-specimen is iron-grey, and it is highly vesicular. There is no porphyritic feldspar, though green augite and olivine are distinct. In section there is found to be much feldspar in crystals of small size but much twinned; it is of a basic type, bytownite-labradorite. The augite is near diopside, but slightly pleochroic. The crystals of olivine are generally crowded with magnetite-dust. This appears to be an alteration of a somewhat unusual nature, as no mention of it can be found in text-books. A similar alteration occurs in the olivine of a dyke which traverses the scoria cone of Mount Eden, at Auckland, and also in basaltic rocks which occur near the margin of the pipe of the great central volcano of Tahiti, though in the last instance the change is marginal or restricted to the border of the cracks which traverse the mineral. It is still more noticeable in the peridotite that forms part of the pipe of Tahiti.

The groundmass of this Ambrym rock consists of feldspar and augite with magnetite. The augite of the groundmass is greenish, but often with a brown margin.

It will be seen that these rocks are all basalts, and it is stated by Mawson that all the recent products of volcanic activity in the New Hebrides are basaltic, though earlier eruptions were associated with the emission of andesitic rocks.

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* "Geology of New Hebrides," Proc. Linn. Soc. N.S.W., 1905, p. 463, pl. xxiii, fig. 4.

Art. XLII.—*Brachiopod Genera: The Position of Shells with Magaselliform Loops, and of Shells with Bouchardiform Beak Characters.*

By J. Allan Thomson, M.A., D.Sc., F.G.S.

[*Read before the Wellington Philosophical Society, 28th October, 1914.*]

The genus *Magasella* was founded in 1870 by Dall* for shells for erly included under *Terebratella*, but distinguished from *Terebratellae* proper by the possession of a high septum and by the fact that the reflected portion of the loop forms a ring behind the upper portion of the septum.

It was subsequently discovered that during growth *Terebratella* passes through a stage exactly comparable to *Magasella*, and that *Magellania* (*M. venosa*) passes through stages comparable to *Magasella* and *Terebratella*†; and, further, that a large number of species that had been described as *Magasellae* were in reality only the young of known species of *Terebratella* and *Magellania*. This proved to be the case with *Terebratella evansi* Davidson, which Dall had chosen as the type of his genus *Magasella*, for this species, originally described from Lyall Bay, Wellington, is a young form of the common New Zealand shell *Terebratella sanguinea* Leach. According to a strict application of the law of priority, then, *Magasella* is a synonym of *Terebratella*. As there are, however, shells with Magaselliform loops which are undoubtedly adult, a generic name embodying Dall's intentions is necessary, and at first sight it appears to be a case in which the law of priority might be set aside with advantage. This course was followed by Deslongschamps,‡ who proposed the South Australian Recent shell *Terebratella cumingi* Davidson as the genotype, in place of *T. evansi*. If all shells with Magaselliform loop characters could be placed in *Magasella* thus emended, this course would have no other objection than the lack of finality that must always attach to any alteration of the law of priority. As will be shown below, however, Magaselliform loop characters may be attained independently in more than one stock, and a different procedure becomes necessary. Bucl.man has already pointed out this polygenetic origin of loop characters in the case of shells hitherto placed under *Magellania* and *Terebratella*.§

"It may be remarked that as species of *Magellania* pass through a Terebratelliform stage in their ontogeny, pointing to a Terebratelliform stage of phylogeny, the names *Magellania* and *Terebratella* do no indicate proper generic divisions, but mark the stage of loop-development attained. It is therefore more likely that certain *Magellaniae* are really *Terebratellae* which have attained the Magellaniform loop, and that certain *Terebratellae* are really *Magellaniae* which have not yet lost the Terebratelliform loop. This means that a rearrangement of these genera to correspond with vertical lines of descent instead of to indicate horizontal lines of developmental stages may be anticipated. It is known that among Terebratuloid forms the shape (test and ornament) may change considerably while the loop remains without much modification; and, on the other hand, that the loop may change considerably while the shape remains little altered."

* Am. Journ. Conch., vol. 6 (1870), p. 97, fig. 18.
† P. Fischer and D.-P. Oehlert, Bull. Soc. Hist. nat. d'Autun, t. 5 (1892), pp. 254–334.
‡ Études critiques sur des Brachiopodes, &c. (1884), p. 204.
§ Wissensch. Ergebn. Schwed. Südpolar-Exped., 1901–3, bd. iii, lief. 7 (1910), pp. 21, 22.

It will clear the ground to indicate first the validity of the genera *Neothyris* Douvillé and *Pachymagas* Ihering. Douvillé* separated *Neothyris* (genotype, *Terebratula lenticularis* Desh.) from *Waldheimia*† (genotype, *Terebratula australis* Quoy and Gaimard = *T. flavescens* Lamarck) on grounds of different types of folding. The former he placed among the *Cinctae*, stating that the valves are without folds and the commissure almost plane. It is true that the valves are almost without folds, but the anterior commissure exhibits a slight but distinct anterior depression, a feature more strongly marked in related species, and due to incipient ventral uniplication. The folding, therefore, places this species among the *Nucleatae*, and not among the *Cinctae*. In the other species, *Waldheimia flavescens* (*Magellania*), Douvillé distinguished primary and secondary folds, and placed the species, on account of its primary folds, in the group of *Courctatae*—*i.e.*, antiplicate or ventrally biplicate. In this respect Douvillé was, I believe, justified.‡ The biplication is certainly slight in *M. flavescens*, but it is quite well marked in certain Australian Tertiary forms, such as *M. grandis*, *M. garribaldiana*, and *M. divaricata*. Nevertheless, it is not in itself a character of generic importance in this case. The whole of the *Magellaninae*, if folded at all, show a dominant ventral uniplication,§ and the feeble ventral biplication is only a slight modification of this, and has arisen independently in more than one evolutionary stock. Actually it appears to be confined to Australian forms, but it is not yet certain that they will all come under *Magellania* s. str.

There is, however, another important difference between *M. lenticularis* and *M. flavescens*, and it is precisely that used by Ihering in 1903 to distinguish *Pachymagas* from *Terebratella*—viz., the difference in the hinge-plate and cardinal process. "*Comparée avec* T. dorsata, *le plateau cardinal, comme aussi ses annexes et le septum, sont extrêmement grossis et ces caractères servent pour établir un sous-genre, pour lequel je propose le nom de* Pachymagas. *L'espèce typique est* T. tehuelca *et il faut placer dans le même sous-genre,* T. gigantea *Ortm. et* venter *Ih. Toutes ces espèces sont éteintes et restreintes aux dépôts tertiares de la Patagonie ; toutes ont la coquille lisse, tandis que dans* Terebratella *s. str., le processus cardinal, les crura et le septum sont minces, plus ou moins lamellaires et la surface externe des valves est munie de larges côtes rayonnantes.*"‖

Before discussing the cardinal process and other hinge parts it will be convenient to dispose of the accessory character of multicostation, which is shared both by *M. flavescens* and *T. dorsata*, the genotypes of *Magellania* and *Terebratella* respectively. It is confined, among the higher genera of

* Bull. Soc. Geol. Fr., t. 7 (1879), pp. 273–75.

† *Waldheimia* was found to be preoccupied, and the name was changed to *Magellania* by Bayle in 1880.

‡ Buckman apparently did not recognize the biplication. He says (Quart. Journ. Geol. Soc., vol. 63 (1907), p. 342), "Hall and Clarke speak of *Magellania numismalis*, the present *Cincta* ; but *M. flavescens* has not come through a *Cincta* stage, and shows no sign of anterior retardation of the *Cincta* type. What it does show a little indication of is a uniplicate stage, but reversed as compared with *Terebratula whitakeri*—that is, it is ventrally, not dorsally, plicate."

§ With the exception only of *Magasella vercoi* Blockman, which shows slight dorsal uniplication, and of *M. adamsi* Davidson, a species whose position in the *Magellaninae* is not unequivocal. It is probably not an adult shell, and may be the young of some member of the *Dallininae*.

‖ H. von Ihering, "Les Brachiopodes Tertiares de Patagonie," Ann. Mus. Nac. Buenos Aires, tom. 9 (1903), p. 332.

the *Magellaninae*, to species which come under *Terebratella* and *Magellania* s. str., if these be defined by the type of hinge; but there are species in each of these genera which do not exhibit this property. *Terebratella rubicunda* is nearly smooth, showing only a slight crinkling near the margin in old shells, while *Terebratella oamarutica* Hutton is perfectly smooth. A Recent species of *Magellania* from Macquarie Island collected on the Mawson Expedition by Mr. H. Hamilton is also perfectly smooth. Multicostation, therefore, although constantly absent in *Pachymagas* and *Neothyris*, cannot be considered a property on which to base generic distinctions. These must rest primarily on the types of hinge parts and cardinal process.*

Types of Hinge Parts and Cardinal Process.

(*a.*) *The Terebratelliform Type.* Fig. 1.

In *M. flavescens*, *T. dorsata*, *T. sanguinea*, and *T. rubicunda*—*i.e.*, in *Magellania* s. str. and *Terebratella* s. str.—the socket-ridges, hinge-plates, septum, &c., are frequently described as lamellae, in reference to the fact that they are thin and sometimes almost transparent. The hinge-plates are hollowed underneath (fig. 1, *b*), and if they be broken away it is found that the septum extends beneath them right to the umbo of the valve. The cardinal process is superimposed on the posterior end of the hinge-plates, and consists of a thin plate, broader than long, curving forward, and excavated on the upper side to form a rounded cup or socket to which the diductor muscles are attached.

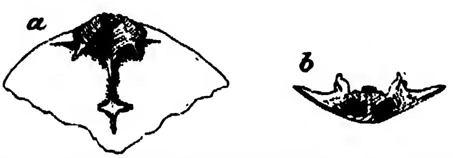

Fig. 1.—*Terebratella sanguinea* (Leach), Wellington Harbour. Interior of dorsal valve. *a.* View from above. *b.* Front view of hinder end broken off, showing shell and septum in section, lower sides of hinge-plates in perspective.

(*b.*) *Pachymagoid and Neothyroid Types.* Fig. 2.

In *Terebratella parki* Hutton and in other species referable to *Pachymagas*, and in *M. lenticularis* and other species referable to *Neothyris*, the socket-ridges, crural bases, and septum are thick and solid, and cannot be described as lamellae. The socket-ridges nearly meet at the umbo, and thence diverge more or less obliquely. The crural bases make junction with them on their inner anterior corners, and are so intimately fused with them at this point that they cannot generally be traced any farther posteriorly; but in some species (*N. lenticularis*, *N. ovalis*) they can be distinguished along the inner sides of the socket-ridges for their whole length. The septum does not extend as such to the umbo, but bifurcates posteriorly to join the inner anterior ends of the socket-ridges (near the point of origin of the crural bases as distinct processes). There are no definite hinge-plates as in Terebratelliform types, their place being taken by the more or less steep inner walls of the socket-ridges, which, with the bifurcating process of the septum, enclose a trough which we may term the "hinge-trough." The cardinal process rises from the bottom of the hinge-trough, and varies greatly in different species. In New Zealand older Tertiary examples of *Pachymagas* it is always fairly simple, but differs greatly in size and height. In its most

* That is to say, these characters best serve to distinguish the evolutionary stocks.

primitive form it is very short, being confined to the posterior part of the hinge-trough, and is also very low, in shape being a pyramid with an edge facing forwards and a hollowed side behind. In more advanced types the process gains both in length, occupying more and more of the hinge-

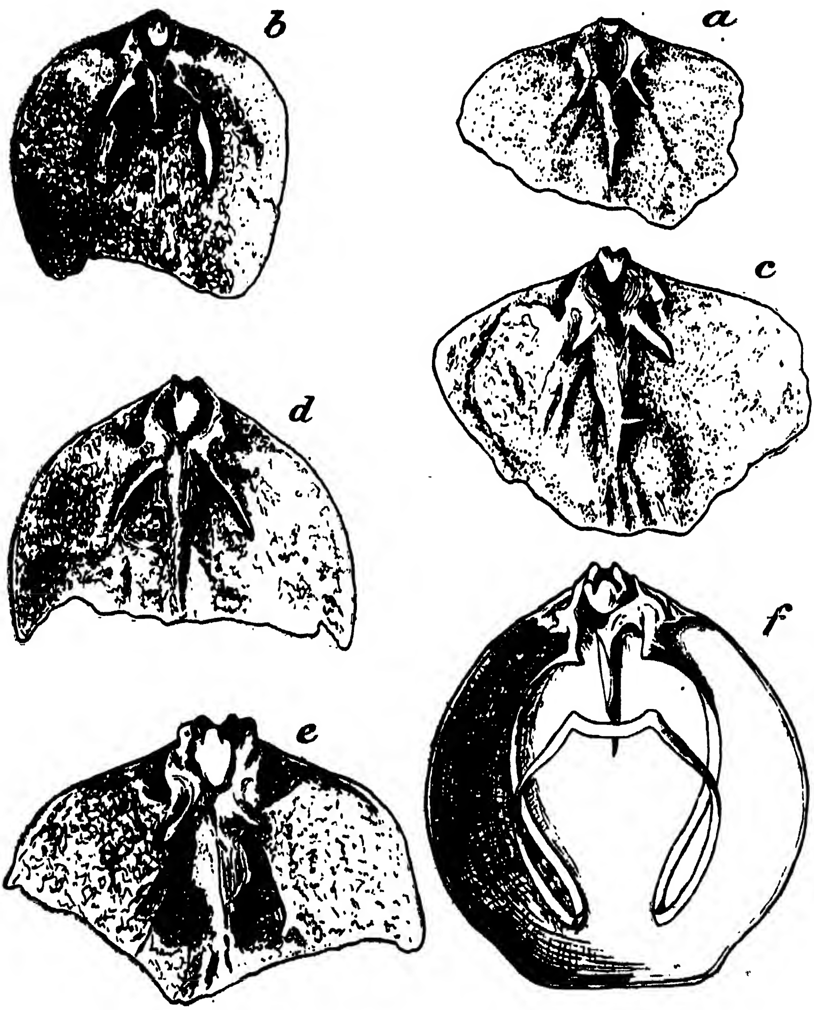

FIG. 2.—Interiors of dorsal valves of *Pachymagas* and *Neothyris*, showing evolution of cardinal process. *a. P. parki* (Hutton), Kakanui greensands. *b. P. parki* (Hutton), Hutchinson's Quarry greensands. c. *P. huttoni* sp. nov. (see appendix), Wharekuri greensands. *d. N. ovalis* (Hutton), Shakespeare Cliff, Wanganui. *e. N. ovalis* (Hutton), Castlecliff, Wanganui. *f. N. lenticularis* (Desh.), Recent (after Davidson).

trough, and in height, projecting above the socket-ridges, while the hollow behind is now confined to its base, and is bounded by two lateral ridges. In the most advanced types met with in New Zealand species of *Pachymagas* there is a slight posterior median ridge in the

upper part of the process, and this ridge becomes still more accentuated in the Patagonian late Tertiary species, including *P. tehuelca*, the genotype, and in the most primitive species of *Neothyris* in New Zealand, while at the same time the process gains still further in length and height. Finally, in *N. lenticularis* the process is so large that it fills the whole of the hinge-trough, and almost hides the bifurcation of the septum; the posterior median ridge is strongly marked, while the two lateral ridges bounding the hollow facet at the bottom of the posterior part of the process are greatly developed, and incurved so that they nearly meet to form a tube.

The great resemblance in hinge characters between *Terebratella dorsata* and *Magellania flavescens* on the one hand, and between *Pachymagas tehuelca* and *Neothyris lenticularis* on the other, makes it certain that *M. flavescens* had an ancestral form with Terebratelliform loop and Terebratelliform hinge characters, while *N. lenticularis* had an ancestor with Terebratelliform loop and Pachymagoid hinge characters. Corroborative evidence would be furnished by a study of the hinge characters of the young stages of these species, sufficient material for which I possess only in the case of the former stock.

In *M. flavescens*, *T. sanguinea*, and *T. rubicunda*, Terebratelliform hinge characters can be recognized not only in specimens with Terebratelliform loops, but in specimens with Magaselliform loops. Young specimens of fossil *Pachymagas* also possess Pachymagoid hinge characters at a stage when the loop is Magaselliform. We are thus in a position to recognize two stocks, typified in their highest development by *M. flavescens* and *N. lenticularis*, and to state that the generic distinctions between *Terebratella* and *Pachymagas* on the one hand, and between *Magellania* and *Neothyris* on the other, are well founded.

Magella gen. nov.

No adult specimen with Pachymagoid hinge and Magaselliform loop has yet been described, but there is in the Kakanui limestone (Oamaruian) a species with Terebratelliform hinge characters and Magaselliform loop—viz., *Terebratella kakanuiensis* Thomson* *non* Hutton. This species I now rename *Magella carinata*,† and make it the type of a new genus *Magella*, the essential characters being those already indicated. In old specimens the loop is rather more advanced, and the septum correspondingly lower, than in most species placed under *Magasella*; but the pattern is still Magaselliform and not Terebratelliform, as fig. 3 shows, and the septum is still much higher in front than behind. The deltidial plates are discrete, as in the young of *Terebratella* and *Magellania*.

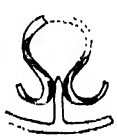

FIG. 3.—*Magella carinata* Thomson, Kakanui limestone. Interior of dorsal valve, end view, showing loop touching septum.

There are probably a large number of described species which may be transferred to *Magella*. In some with Terebratelliform hinge the loop is more primitive, being in the stage called by Fischer and Oehlert

* Trans. N.Z. Inst., vol. 40 (1908), p. 102, pl. xiv, fig. 4, *a–c*.

† The holotype of this species is the specimen figured by me in 1908, and now in the Otago Museum.

"Magadiform." These may, nevertheless, be placed in *Magella*, which will then include all species of the *Terebratella-Magellania* stock which have not attained at maturity the *Terebratella* stage of loop. Amongst such species with primitive loops are *Magasella australis* Buckman, from the *Pecten* conglomerate (Pleistocene) of Cockburn Island, off Graham Land, West Antarctica; *Magasella gouldi* Dall, from the Recent seas of Japan, which is possibly only a young stage of *Magellania grayi* or some other species; and *Magasella aleutica* Dall.

Magasella flexuosa (King), if a valid species, as Ihering contends, is certainly a *Magella*, but it is usually considered a young stage of *Terebratella dorsata*, and the same is true of *Magasella patagonica* (Gould). Similarly *Magasella* (?) *laevis* Dall is probably the young of *Magellania venosa*. It is probable that *Terebratella woodsi* Tate, from the Table Cape beds of Tasmania, and *Terebratella pumila* Tate, from the Gippsland Lakes, will be found on dissection to belong to *Magella*, as they agree pretty closely with the genotype in external characters. Finally, *Magasella antarctica* Buckman, from the glauconitic bank, Cockburn Island, described by Buckman as possibly the Magaselliform ancestor of *Terebratella rubicunda*, is without doubt to be transferred here.*

SHELLS WITH BOUCHARDIFORM BEAK CHARACTERS.

All the known species of *Bouchardia*, though differing somewhat in length and breadth, and in the amount of ventral uniplication or unicarination, possess similar and rather unusual beak characters—viz., the beak is incurved only at its apex, and then but slightly; there are sharp beak-ridges uniting in front of the foramen, which is thus behind the apex, the false area is prominent, and the pseudo-deltidium strong, solid, and blended with the shell. These characters are illustrated in fig. 4, which comprises all the known species of *Bouchardia*.†

Now, there are in New Zealand older Tertiary (Oamaruian) a series of shells which bear out Buckman's dictum that "the loop may change considerably while the shape remains little altered." These shells have Bouchardiform beak characters, and, although much larger in size, they are externally so like *Bouchardia* that they were described as such by Hutton in 1905‡ under the names of *B. rhizoida* and *B. tapirina* (not *Waldheimia tapirina* Hutton, 1873). Buckman, accepting Hutton's generic determination, compared them with the other known species of *Bouchardia*, and considered that in shape the New Zealand species were biologically the earliest. In spite of this undoubtedly primitive shape, these specimens have proved to possess Magellaniform loops and septa (fig. 5).§ It is more

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* Jackson (Trans. Roy. Soc. Edin., vol. 48 (1912), pp. 384–85) considers this species the young of *Terebratella dorsata*, erroneously ascribing the glauconitic bank to Pleistocene, whereas Buckman gives its age as Miocene-Oligocene. This greater age makes it more probable that *M. antarctica* is an ancestral form of *Terebratella dorsata* than a young specimen. Buckman considered it ancestral to *T. rubicunda*, but one would hardly expect even incipient multicostation, such as *M. antarctica* shows, on a Miocene ancestor of *T. rubicunda*.

† With the exception of *B. patagonica jorgensis* Ihering, the original description of which I have been unable to consult.

‡ Trans. N.Z. Inst., vol. 37 (1905), p. 480, pl. xlvi, figs. 6, 7. The beak characters are not correctly rendered in the figures.

§ I obtained from Target Gully, Oamaru, a hollow specimen of *B. rhizoida* with a complete loop, but unfortunately it was destroyed in removal.

than probable, therefore, that the ancestors of these species which possessed Magasselliform and Terebratelliform loops also had Bouchardiform shape

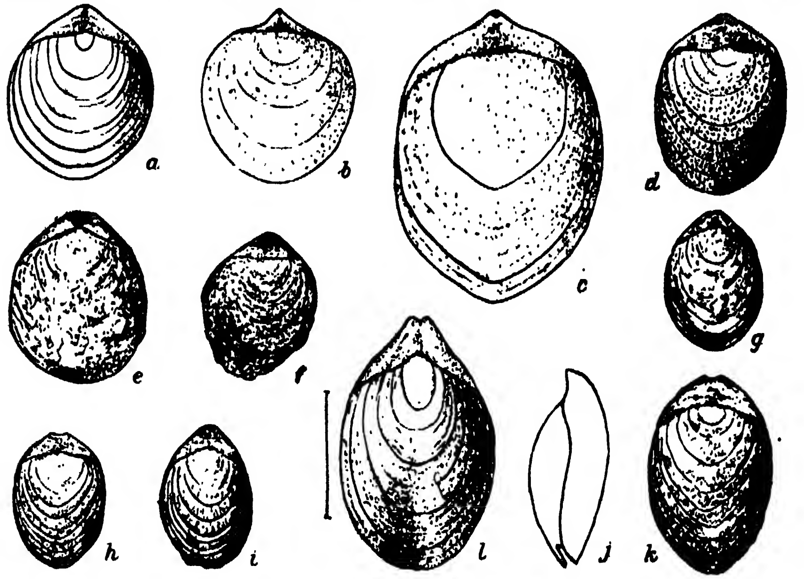

FIG. 4.—Species of *Bouchardia*. *a–d*. South American (after Ihering). *a*. *B. zitteli* Ihering (twice natural size). *b*. *B. patagonica* Ihering (twice natural size), Patagonian formation. *c*. *B. zitteli* Ihering, holotype (twice natural size), Patagonian formation. *d*. *B. transplatina* Ihering (very slightly enlarged), Entrerian formation. *e–k*. Younger beds, Seymour Island, off Graham Land, Antarctica (after Buckman), (natural size). *e*. *B. ovalis* Buckman. *f*, *j*, *k*. *B. antarctica* Buckman. *g*. *B. elliptica* Buckman. *h*. *B. angusta* Buckman. *i*. *B. attenuata* Buckman. *l*. *B. rosea* (Mawe), Recent, Brazil (after Davidson).

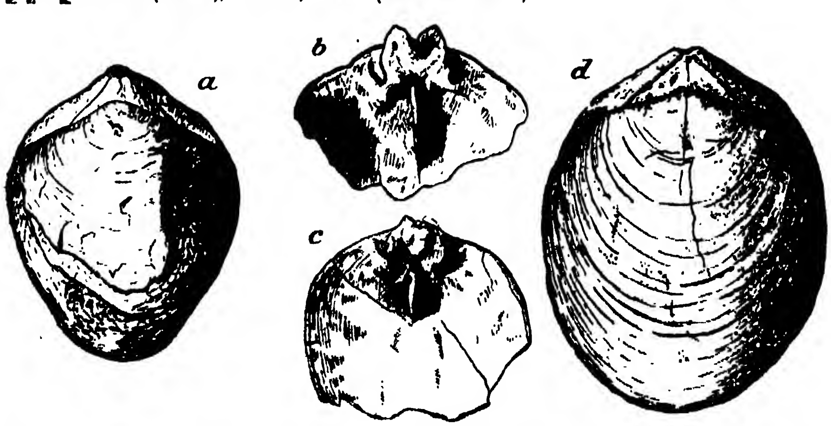

FIG. 5.—*Rhizothyris rhizoida* (Hutton). *a*. Holotype, Mount Brown beds, Weka Pass (specimen in the Canterbury Museum). *b*. Interior of dorsal valve, Weka Pass. *c*. Interior of dorsal valve, Huchinson's Quarry. *d*. Form with nearly straight sides, Weka Pass. (Figs. *a–c* by Dr. C. A. Cotton.)

and beak characters, and, if this be so, we must be dealing with a third stock which has attained independently the Magellaniform loop. In any

case, the hinge-pattern of these shells prevents their inclusion in either *Magellania* or *Neothyris*. Consequently a new genus is necessary, for which I propose—

Rhizothyris gen. nov.

Genotype, *Bouchardia rhizoida* Hutton.

The other species, *Bouchardia tapirina* Hutton (non *Waldheimia tapirina* Hutton), I now rename *Rhizothyris curiosa*, the holotype being a specimen in the Dominion Museum from the Curiosity Shop beds, Rakaia River, Canterbury (fig. 6).

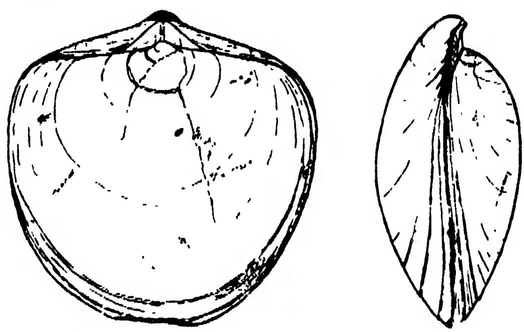

FIG. 6.—*Rhizothyris curiosa* Thomson, holotype, Curiosity Shop. (Figs. by Dr. C. A. Cotton.)

Fortunately, we can point to shells both with Magaselliform and with Terebratelliform loops which possess Bouchardiform shape and beak characters, and thus fill the gap between *Bouchardia* and *Rhizothyris* These shells require separate generic recognition, and for the former I propose—

Magadina gen. nov.

Genotype, *Magadina browni* sp. nov., Mount Brown beds, Waipara district, North Canterbury (fig. 7). (See appendix.)

Besides the genotype and *Magadina waiparensis* (fig. 8), another new species from the Mount Brown beds, there are several already-described

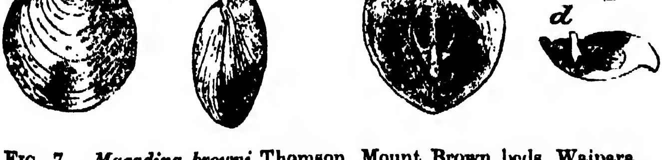

FIG. 7.—*Magadina browni* Thomson, Mount Brown beds, Waipara, Weka Pass district. *a*, *b*. Holotype (twice natural size). *c*. Interior of dorsal valve, paratype (twice natural size). *d*. Partial interior of both valves, paratype (natural size).

forms, all Australian, which combine Bouchardiform shape with Magaselliform loops. Such are *Magasella cretacea* Etheridge (fig. 9), *Terebratula compta* Sowerby (fig. 10), *Magasella compta* Tate (? of Sowerby), a species

which has attained biplication (fig. 11), and the Recent well-known *Terebratella cumingi* Davidson (fig. 12). Possibly also *Magasella tenisoni* Tenison-Woods belongs here. The unity in shape of these species and their distinctness from those ascribed above to *Magella* will be easily recognized.

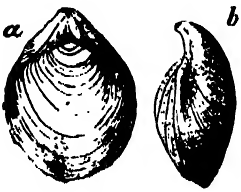

FIG. 8.

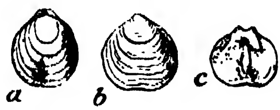

FIG. 9.

FIG. 10.

FIG. 8.—*Magadina waiparensis* Thomson, Mount Brown beds, Middle Waipara district, holotype (twice natural size).
FIG. 9.—*Magadina cretacea* (Etheridge), Gingin beds, Western Australia (after Etheridge), (twice natural size). *a.* Dorsal valve. *b.* Ventral valve. c. Interior of dorsal valve.
FIG. 10.—*Magadina compta* Sowerby, Port Fairy, Cape Otway coast, Victoria (after Sowerby).

In loop characters *Magadina browni* is much less advanced than *Magella carinata*, the descending and ascending branches being separately attached to the septum, which reaches to the opposite valve. This stage, termed "Magadiform" by Fischer and Oehlert, differs from that of *Magas* in

FIG. 11.

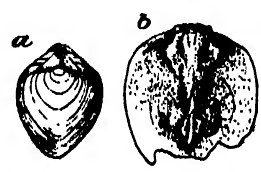

FIG. 12.

FIG. 11.—*Magadina compta* Tate (? of Sowerby), Mannum, R. Murray (after Tate).
FIG. 12.—*Magadina cumingi* (Davidson), Backstairs Passage, South Australia (after specimens in the Dominion Museum supplied by Dr. Verco). *a.* Dorsal view (natural size). *b.* Interior of dorsal valve (enlarged).

that the ascending branches form a complete ring, and it may now more appropriately be termed "Magadiniform." *Magadina cumingi* possesses a Magadiniform loop almost to adolescence, and finally attains an early Magelliform loop.

Magadinella gen. nov.

Genotype, *Magasella woodsiana* Tate* (fig. 13).

The beak characters of this species are not strictly Bouchardiform, the modifications being slightly greater incurvature and less sharp beak-ridges.

* Trans. Roy. Soc. S. Austral., vol. 3 (1880), pp. 163–64, pl. x, fig. 3, *a–d*.

Nevertheless, its nearness in shape to *Magadina* is shown by the fact that Tate states that it bears considerable external resemblance to *M. cumingi*, while Pritchard has placed it as a synonym of *M. compta.** The loop is much more advanced than that of *Magadina*, however, being an early Terebratelliform stage. Its hinge characters, described below, are quite distinct from those of *Terebratella* and *Pachymagas*. Although, from the

FIG. 13.—*Magadinella woodsiana* (Tate), River Murray.
(After specimens in the Dominion Museum.)

slight difference in beak characters, *Magadinella woodsiana* cannot possibly itself be an ancestral form of *Rhizothyris*, the forerunner of *Rhizothyris* with Terebratelliform loop may be placed, when it is found, under *Magadinella*.

HINGE CHARACTERS OF THE BOUCHARDIA-RHIZOTHYRIS SERIES.

In *Bouchardia* the posterior parts of the valves are much thickened, the hinge-teeth of the ventral valve are strongly bifid, while in the dorsal valve the fusion of the parts prevents exact comparison with the socket-ridges, cardinal process, &c., of more advanced genera. The adductor and diductor muscular impressions are situated anteriorly in the ventral valve, and are divided by a low median ridge. In *Magadina* the valves are still somewhat thickened posteriorly, the hinge-teeth are more strongly bifid than in advanced genera, while the median ridge separating the muscular impressions on the ventral valve is still situated anteriorly. The thickened hinge parts of the dorsal valve consist principally of two socket-ridges, which posteriorly are separate and taper each nearly to a point, projecting considerably behind the umbo, but anteriorly are very solid, and unite with one another in front of the septum. Between them, behind their anterior junction, there is a small but deep hinge-trough, in which a cardinal process lies. In *Magadina browni* this process is very small, but in *M. cumingi* it is large and solid, without sharp angles, and completely fills and obscures the hinge-trough. The septum, high in front, low behind, joins the anterior junction of the socket-ridges without bifurcation.

In *Magadinella* the posterior thickening of the valves is greatly reduced, while the muscular impressions of the ventral valve are situated posteriorly as in other advanced genera. The septum is long but low,† so that the loop is probably in an early Terebratelliform stage. The hinge characters, however, still present considerable resemblance to those of *Magadina*. The socket-ridges are swollen anteriorly, almost uniting in the middle, where they are joined by an unbifurcated septum; posteriorly they become attenuated, and project considerably behind the umbo. The hinge-trough

* Proc. Roy. Soc. Vict., n.s., vol. 8 (1896), p. 143.

† Tate's figure shows a septum moderately high anteriorly, due probably to the youth of the shell figured.

is roomy, and only partially filled by a small cardinal process pointing obliquely forward, and expanded to form an excavated trefoil above.

In *Rhizothyris* the socket-ridges are thickened, and almost unite anteriorly, where they are joined by a short stout unbifurcated septum. In *R. curiosa* the cardinal process is small and similar to that of *Magadina browni*; in *R. rhizoida* it is large and swollen, and often fused with the septum and socket-ridges, but in specimens where it is distinct it is essentially similar to that of *Magadina cumingi*.

It will thus be seen that, while retaining Bouchardiform shape, there is an evolution shown in this series not only in loop characters, but also in hinge characters. While the loop has evolved until in *Rhizothyris* it is indistinguishable from that of *Magellania*, the hinge has remained much more simple, not showing the bifurcation of the septum which is so prominent in *Neothyris* and *Pachymagas*.

Other Stocks.

In the above account all known shells with Bouchardiform beak characters have been discussed, and the majority of the known species of *Magasella* have been transferred to the Magaselloid genera, *Magella* and *Magadina*, while the probable existence of a third Magaselloid genera belonging to the *Pachymagas-Neothyris* stock has been indicated. There are still numerous species of *Terebratella* and *Magellania*, sensu lato, which will not fit into any of the genera above described, but their treatment must be postponed until a revision of the Tertiary Brachiopods of Australia and South America has been made with special regard to the hinge characters. There are also certain Recent species of *Magasella* still unplaced, notably the South Australian forms *Magasella vercoi* Blockman and *M. exarata* Verco. The name *Magasella* may still conveniently be retained in a wide sense as a temporary designation for species whose relationship is not clear.

With regard to the relationship of the evolutionary stocks already indicated, it is probable that *Bouchardia* is a retrograde genus from a forerunner of *Magadina*, and that from the latter genus, by an anterior enlargement of the hinge-trough, the Magaselliform forerunner of *Pachymagas* has evolved. From this suppositional genus, by evolution of loop characters *Pachymagas* and *Neothyris* have evolved on the one side, and by a further reduction in the calcification of the hinge *Magella* has evolved on the other side, giving rise later by evolution of the loop to *Terebratella* and *Magellania*.

APPENDIX: DESCRIPTIONS OF NEW SPECIES.

Magadina browni sp. nov. Fig. 7, *a–d*.

Description.—Shell rounded pentagonal, slightly longer than broad, greatest breadth posterior to the middle, sides nearly straight, front more or less tapering; hinge-line nearly straight; dorsal valve nearly flat, with a short but often pronounced anterior sinus; ventral valve moderately convex, with a median carination; commissures with a well-marked anterior sinuation, sometimes narrow and deep, sometimes broad and shallower; beak short, not incurved, truncated obliquely by a relatively large, nearly

round foramen whose anterior lip projects slightly forward; beak-ridges fairly sharp, delimiting a false area, the greater part of which is occupied by a large solid concave pseudo-deltidium. Surface of valves smooth with numerous strong growth-lines.

Dimensions in Millimetres.—	Length.	Breadth.	Thickness.
Holotype	10	8·5	5·3
Paratypes	10·6	7	5
	11	10	4·8
	9·8	9	4·8

Type Locality.—Base of main limestone, cuesta between Mount Brown and the Waipara River, North Canterbury.

Magadina waiparensis sp. nov. Fig. 8, *a*, *b*.

This species so closely resembles *M. browni* that the differences only need be indicated. *M. waiparensis* is slightly more elongate, more convex, and the dorsal valve more arched from back to front. The beak is much more produced, and more incurved, and in consequence the pseudo-deltitidium is higher and more concave.

Dimensions in Millimetres.—	Length.	Breadth.	Thickness.
Holotype	11	8·3	5·5
Paratypes	10·4	7·8	5·8
	11·3	9	5·5

Type Locality.— Lowest Mount Brown limestone, in cliffs of the Deans-Waipara cuesta opposite the Ram's Paddock, Middle Waipara district, North Canterbury.

Pachymagas huttoni sp. nov. Fig. 2, *c*.

1905. *Magellania triangularis* Hutton, Trans. N.Z. Inst., vol. 37, p. 477 (not the species of 1873).

Description.—Shell suborbicular, greatest width about the middle; hinge-line short, obtusely angular. Dorsal valve depressed, with a faint anterior sinus, slightly produced and reflected in front; ventral valve strongly and broadly carinated, sides rather flattened; margins of valves fairly sharp; anterior commissure with a broad moderately deep anterior sinuation. Beak small, inflated, not greatly incurved, truncated by a moderately large circular foramen; beak-ridges fairly sharp, pseudo-deltidium broad, low, concave. Surface of valves smooth with numerous growth-lines.

Dimensions of Holotype.—*	Length.	Breadth.	Thickness.
	43 mm.	41 mm.	23 mm.

Type Locality.—Maerewhenua limestone, crossing of Awamoko River, north of Ngapara.

* The holotype is in the Dominion Museum, and is not the specimen here figured.

ART. XLIII.—*Additions to the Knowledge of the Recent* Brachiopoda *of New Zealand.*

By J. ALLAN THOMSON, M.A., D.Sc., F.G.S.

[*Read before the Wellington Philosophical Society, 28th October, 1914.*]

THERE are only four valid species of Brachiopod described from New Zealand waters—viz., *Hemithyris nigricans* (Sowerby), *Neothyris lenticularis* (Deshayes), *Terebratella sanguinea* (Leach), *Terebratella rubicunda* Sowerby. The occurrence of a fifth species, *Crania* sp. ind., has been indicated by Hutton* and Hamilton.† To this list I am now able to add four species, the locality of one of which is doubtful. Two species formerly included in Hutton's lists—viz., *Magadina cumingi* (Davidson) and *Kraussina lamarckiana* (Davidson)—are well-known Australian species, whose occurrence in New Zealand has not been verified during the last forty years, and they should be omitted from our lists.

Since the publication in 1887 of part ii of Davidson's "Monograph of Recent *Brachiopoda*"‡ no further study of the New Zealand forms has been made. Nevertheless, since that date observations of the greatest importance, affecting the whole classification, have been made on the South American forms,§ showing that the genera *Magasella, Magas, Terebratella,* and *Magellania* are related in such a way that the loops of the higher genera pass during growth through forms comparable with the adult loops of the lower genera. Beecher‖ has contrasted this series of growth stages with those of *Macandrevia cranium* and of some other northern species formerly assigned to *Terebratella* and *Magellania*, and, on account of the differences displayed, has founded for these species the genera *Terebratalia* and *Dallina,* placing them along with *Macandrevia* in a new subfamily, the *Dallininae.* Beecher rather hastily assumed that the *Dallininae* were entirely confined to the Northern Hemisphere and the *Magellaninae* to the Southern, and, this assumption being until recently unchallenged, it has not seemed a matter of urgency to study the growth stages of other species ascribed to the above-mentioned genera. Jackson,¶ however, has recently shown that a species of *Macandrevia* ranges from the Gulf of Panama to Coats Land, Antarctica, thus proving the occurrence of the *Dallininae* in the Southern Hemisphere. The occurrence of species of *Magasella* in the Northern Pacific has long been known, but their significance appears to have been overlooked. Elsewhere** I have shown that certain species of the Northern Pacific now generally ascribed to *Terebratalia* and *Dallina* have not the type of folding typical of members of that stock of the *Dallininae*, but that characteristic of the *Magellaninae*, and that on this account these species should probably be referred back to *Terebratella*†† and *Magellania*.

These circumstances in themselves make a study of the young stages of all Recent Brachiopods belonging to the *Terebratellidae* desirable, more

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* Cat. Marine Mollusca N.Z. (1873), p. 87.

† Colonial Museum Bull. No. 1 (1906), p. 41.

‡ Trans. Linn. Soc. Lond., ser. 2, Zool., vol. 4, pt. i (1886), pt. ii (1887).

§ P. Fischer and D.-P. Oehlert, Bull. Soc. Hist. nat. d'Autun, t. 5 (1892), pp. 254–334.

‖ Trans. Conn. Acad. Arts Sci., vol. 9 (1895), pp. 376–99, pls. i–iii.

¶ Trans. Roy. Soc. Edin., vol. 48 (1912), pp. 379–83.

** Geol. Mag., dec. 6, vol. 2 (1915), pp. 71–76.

†† The genotype of *Terebratalia* come under this category, and if my contention is correct this genus becomes a synonym of *Terebratella*. I have proposed a new genus *Dallinella* as the Terebratelliform forerunner of *Dallina*.

especially those of New Zealand, Australia, Japan, and western North America. When it is further recognized that within the *Magellaninae*, and probably also the *Dallininae*, there are different stocks that have arrived independently at similar loop forms, a knowledge of the growth stages becomes of the highest interest.

YOUNG STAGES OF TEREBRATELLA RUBICUNDA AND TEREBRATELLA SANGUINEA.

Through the kindness of Miss Mestayer and Mr. H. Hamilton I have been able to examine a large number of the young of these species from Chetwode Islands (Cook Strait), Wellington Harbour, and Foveaux Strait. Specific discrimination is possible between these two species down to a length of 3 mm. for the ventral valve; the young of *T. sanguinea* is in general broader, and the multicostation has already commenced as a crinkling on the margins at that length. So far as the development of the loop is concerned, these two species agree almost entirely with *T. dorsata*, the development of which has been described by Fischer and Oehlert.* This is only to be expected, since the New Zealand species belong to *Terebratella* s. str, of which *T. dorsata* is the genotype.

TABLE INDICATING NAMES OF LOOP STAGES IN TEREBRATELLA AND MAGELLANIA.

Fischer and Oehlert.	Beecher.	Names adopted in this Paper.
Pre-Magadiform	Bouchardiform .. / Megerliniform ..	Pre-Magadiniform.
Magadiform	Magadiform ..	Magadiniform } Magaselliform.
Magaselliform	Magaselliform ..	Magelliform }
Terebratelliform	Terebratelliform ..	Terebratelliform.
Magellaniform	Magellaniform ..	Magellaniform.

In the so-called Magadiform stage (fig. 5) the descending and ascending portions of the loop are separately attached to the septum, and the ascending portion forms a complete ring. This is the condition of the adult loop in *Magadina browni*, whereas in *Magas pumilus* the ascending branches, so far as is known, do not unite to form a ring. Moreover, in the growth of the loop of *Terebratella* the ascending portion never passes through a stage where the ring is incomplete. It is therefore desirable to replace the term "Magadiform" by "Magadiniform." Similarly the term "Magaselliform" has not been used in an unequivocal sense. It is restricted by Fischer and Oehlert and Beecher to the stage, later than Magadiniform, where the descending and ascending portions of the loop have united with one another along the side of the septum (fig. 6). This is the stage attained in the adult loop of *Magella carinata*, but many species classed under *Magasella* have not passed the Magadiniform stage. Hence it will conduce to clearness if the term "Magelliform" be used for the later stage, and the term "Magaselliform" be used in a wider sense for both Magadiniform and Magelliform stages—that is, for shells with a high septum rapidly lessening in height posteriorly, and with descending portions of

* *Loc. cit.*

the loop complete. For the earliest stages with a high septum and with the descending portions of the loop incomplete the term "pre-Magadiniform" may be used.

Beecher has compared the pre-Magadiniform stages with the adult condition of the loop in *Bouchardia* and *Megerlina*, but there are important differences which make the use of the terms "Bouchardiform" and

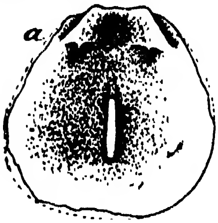


FIG. 1.

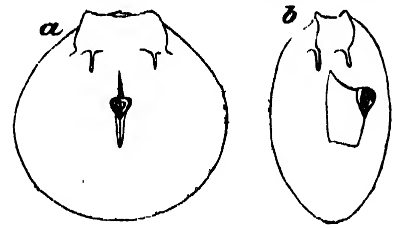


FIG. 2.

FIG. 1.—*Terebratella rubicunda*, Chetwode Islands. Pre-Magadiniform stage, before the appearance of the hood on the septum. Length of ventral valve, 3 mm.
FIG. 2.—*Terebratella rubicunda*, Chetwode Islands. Pre-Magadiniform stage, with small hood on septum. Length of ventral valve, 3·5 mm.

"Megerliniform" misleading. In each of these genera, as in *Magas*, the ascending branches do not unite to form a ring, while in *B. rosea* the descending branches are completely absent. In the young stages of *Terebratella* there is never an incomplete ring, while the growth of the descending branches commences before any indication of the ascending branch can be found on the septum. It is probable that in loop characters *B. rosea* is degenerate from a stock originally possessing pre-Magadiniform characters. The loops of the fossil species of *Bouchardia* are as yet unknown, and their description will possess the highest interest.

In the young of *Terebratella rubicunda* there is a great deal of latitude in the relations between size of shells and stage of loop-development attained. Generally speaking, the Magadiniform characters are attained at a length

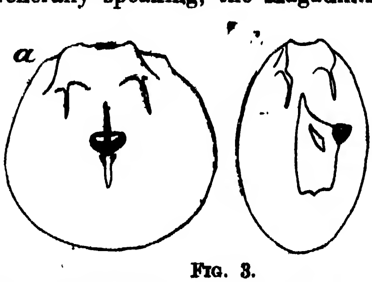


FIG. 3.

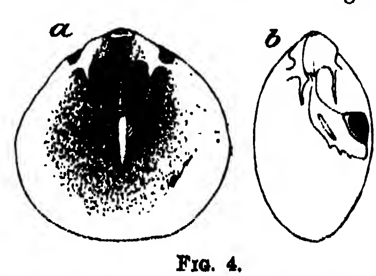


FIG. 4.

FIG. 3.—*Terebratella rubicunda*, Chetwode Islands. Pre-Magadiniform stage, with ring developed from hood. Length of ventral valve, 3·5 mm.
FIG. 4.—*Terebratella rubicunda*, Foveaux Strait. Late pre-Magadiniform stage, retaining a hood on the septum when the descending branches are nearly complete. Length of ventral valve, 6 mm.

of 4 mm., but one specimen of 6 mm. is still in the pre-Magadiniform stage. Magelliform characters usually commence at a length of 6 mm., and are quickly superseded by early Terebratelliform characters.

The only observations I have been able to make on loop-development additional to those of Fischer and Oehlert relate to the very early stages. The growth of the crura commences, as they have pointed out, before any

sign of the ring appears on the septum (fig. 1). I have observed several specimens in a succeeding stage in which a very small hood, not a ring, appears on the posterior end of the septum (fig. 2). The base of this hood later becomes resorbed, and it passes into a ring (fig. 3), but sometimes it persists to a fair size (fig. 4). In the large specimen of 6 mm. previously mentioned, the front parts of the descending branches have already appeared on the septum before the hood has developed into a ring.

Fischer and Oehlert made no observations on the development of the hinge-plate, which is a characteristic of the *Terebratella-Magellania* stock. In their figures of *T. dorsata* the septum does not extend back as far as the hinge-plate until the Magelliform stage is reached, whereas in *T. rubicunda* it passes under the anterior end of the hinge-plate in the Magadiniform, and exceptionally in the pre-Magadiniform, stage. The development of the hinge-plate commences independently of the septum. In very young specimens it starts as two almost vertical plates on the inner sides of the anterior end of the socket-ridges, separated in front from the socket-ridges by a hollow, but behind coalescing with them. Possibly these two plates

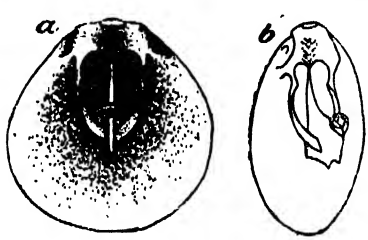


FIG. 5.

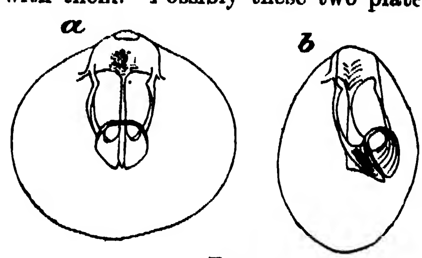


FIG. 6.

FIG. 5.—*Terebratella rubicunda*, Foveaux Strait. Early Magadiniform stage. Length of ventral valve, 4 mm.

FIG. 6.—*Terebratella rubicunda*, Foveaux Strait. Magelliform stage. Length of ventral valve, 8 mm.

are united along the middle line of the valve, but, if so, they are closely applied to the bottom of the valve. In succeeding stages these plates descend from the socket-ridges more and more obliquely, thus gradually approaching one another, while the hollow between them and the floor of the valve gradually increases in size. In later Magadiniform stages, where the septum now reaches back to the region of the hinge, these plates unite above the septum, but farther back they are still applied to the bottom of the valve. Finally, in the Magelliform stages the septum reaches right back under the hinge-plates to the umbo, and the characteristic Terebratelliform hinge characters are attained. The cardinal process appears at the umbo in very early stages in much the same form as it attains at maturity, while the hinge-teeth of the ventral valve are also well developed in the early stages.

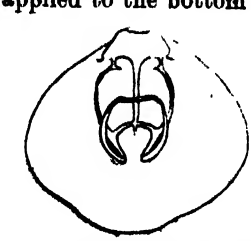


FIG. 7.—*Terebratella rubicunda*, Wellington Harbour. Adult. Length of ventral valve, 19 mm.

The ridge separating the muscular markings of the ventral valve, which is situated anteriorly in *Bouchardia* and *Magadina*, but posteriorly in *Terebratella* and *Magellania*, is well developed in the young stages of *T. rubicunda*, and is situated anteriorly in pre-Magadiniform stages, centrally in the Magadiniform stages, and posteriorly in the higher stages.

The young stages of *Terebratella sanguinea* differ in no important respect from those of *T. rubicunda.*

Young Stages of Neothyris lenticularis.

It is known from the observations and figures of Douvillé* and Davidson† that the loop of this species passes through Magelliform and Terebratelliform stages during growth, and it is probable that the still earlier stages do not differ from those of *Terebratella.* Unfortunately, I have not yet been able to obtain a series of very young shells in which to confirm this, though such a series should not be difficult to obtain from the oyster-dredges of Foveaux Strait. The study of the development of the cardinal process in this species will be of much interest.

Additions to the List of Species occurring in the New Zealand Area.

Liothyrina sp. ind. Fig. 8.

Included in Mr. Hamilton's collection from Foveaux Strait there is a single example of *Liothyrina.* This genus is characterized by a short Terebratuloid loop, a thin shell finely punctate, and the presence of 4 radiating furrows in the interior of the dorsal valve for the attachment of the pallial sinuses, all of which characters are well displayed by the present example.

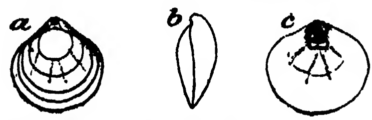


Fig. 8.—*Liothyrina* sp., Foveaux Strait. *a,* dorsal view; *b,* side view; *c,* interior of dorsal valve. Length, 14 mm.

In shape it is suborbicular, and entirely non-plicate, and has all the appearance of a young shell, for which reason I do not propose to give it a specific name at present. The beak characters are hardly typical of *Liothyrina,* which usually has at least slight anterior projection of the lip of the foramen; but, again, this may be due to its youth.

Liothyrina occurs in both the Northern and Southern Hemispheres, but has not been before recorded in the New Zealand-Australian area. It is known from the English chalk, and probably occurs in the Italian Tertiaries, but none of the New Zealand or Australian Tertiary Terebratuloids, though in some cases thin-shelled, appear to belong here. It appears, therefore, to be a recent immigrant to our waters, in contradistinction to our other species, which are all descendants of known Tertiary shells.

Neothyris ovalis (Hutton). Fig. 9.

1886. *Waldheima ovalis* Hutton, Trans. N.Z. Inst., vol. 18, p. 335.

1905. *Magellania lenticularis ovalis* Hutton, Trans. N.Z. Inst., vol. 37, p. 475, pl. xlv, fig. 2.

This species is related to *N. lenticularis,* but differs in shape and also in its less incurved beak and much larger foramen, while the cardinal process is also more primitive. It is abundant in the younger Tertiary

* Bull. Soc. Geol. Fr., ser. 3, t. 7 (1879), p. 256, fig. 3.
† *Loc. cit.,* pt. i, pl. 9., figs. 11, 12, 13.

rocks (Wanganuian) of the North Island, but has not hitherto been found Recent. The specimen here figured was obtained by Captain Bollons from Farewell Spit. The colour is pinkish-red, as in *N. lenticularis*, and the shell is sufficiently translucent for the pallial sinuses to show through.

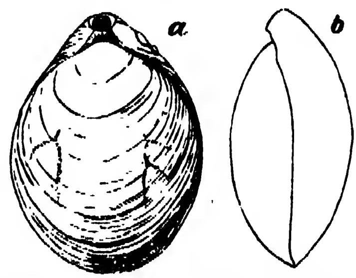


FIG. 9.—*Neothyris ovalis* (Hutton), Cape Farewell Spit. *a*, dorsal view; *b*, side view. Length, 36 mm.

It is rather remarkable that *Neothyris campbellica* Filhol, which is intermediate in characters between *N. ovalis* and *N. lenticularis*, should not also be found Recent. It is a common Wanganuian fossil in the North Island and on Campbell Island.

Terebratella sp. cf. **Magella carinata** Thomson.

In Mr. Hamilton's collection there are four specimens from Foveaux Strait of a new species of *Terebratella*, which differ from *T. rubicunda* by the possession of a more pronounced ventral unicarination, of an incomplete foramen, and of distinctive colour-markings. The shell is of a pale pinkish-white colour, with irregular radial splashing of deep red. Such colour-markings are rare amongst Recent Brachiopods, but occur in *Bouchardia rosea*. In shape the adult shells agree nearly with *Magella carinata*, but the loop has advanced to an early Terebratelliform stage. The four specimens comprise two adults, about the size of small specimens of *T. rubicunda*, and two half-grown shells, not so carinate, and with Magaselliform septa. Unfortunately, the two adults are too damaged to serve as type specimens, and in consequence it is better to leave the species unnamed at present.

It is remarkable that this species, undoubtedly a descendant of the Oamaruian *Magella carinata*, should not be found in the Wanganuian rocks. The explanation may be that it has always been restricted to a southern habitat. *Magella carinata* has only been found near Oamaru, and the present species occurs in Foveaux Strait, still farther south, while no Wanganuian marine rocks are known from Otago or South Canterbury.

Magellania flavescens (Lamarck).

There is in Miss M. Mestayer's collection a single specimen of this species, which probably comes from the Chatham Islands. It was in a box of *Hemithyris nigricans* labelled "Chatham Islands and Lyall Bay," and, since the Lyall Bay habitat has not been confirmed, the probability is that it came from the Chatham Islands. Miss Mestayer is positive that it did not come from Australia. Nevertheless, its occurrence must be verified before it can be added to our list.

The shell is a rather elongate form, with strong ventral uniplication and little sign of biplication, and the multicostation is perhaps a little finer than usual. Nevertheless, it comes well within the range of variation figured by Davidson.

Art. XLIV.—*On the Occurrence of Lower Ordovician Graptolites in Western Otago.*

By T. S. Hall, M.A., D.Sc., University of Melbourne.

Communicated by Professor P. Marshall, M.A., D.Sc., Otago University.

[*Read before the Otago Institute, 5th December, 1911.*]

Plate VII[1].

Through the kindness of Professor P. Marshall, of Dunedin, I have had the opportunity of examining half a dozen small slabs of graptolite-bearing shales collected by Mr. J. S. Nicol, of Gore, at Preservation Inlet, at the extreme south-west corner of New Zealand.

The rocks containing the fossils are of two kinds. Both are dark blue in colour. One is slightly micaceous, and has small white spots of some decomposed mineral in it. It has a somewhat irregular fracture. The other rock is of a darker tint, being almost black, and splits more freely along the bedding-plane. Both rocks are silicified. The graptolites are mostly very distinctly shown, being preserved in a silvery-white mineral which is generally spoken of as gumbelite. Further examination should result in the discovery of a larger supply of better material than has been submitted to me.

The fossils clearly belong to the series known as Lancefieldian in Victoria, which is very low down in the Ordovician, and contains some forms which elsewhere are of Cambrian age. One of the most striking features is the exact resemblance of the darker rock to that which occurs at Lancefield itself. The slabs containing the specimens shown in figs. 1 and 2 may be matched both lithologically and palaeontologically with examples from the Victorian locality, twelve hundred miles away. That both should be similarly silicified is very remarkable.

I have ventured on two specific identifications only, with a separate variety in one case. But besides these several examples are shown of another genus, *Bryograptus*, which may be new, and probably are, but as the thecal characters are not clearly shown I have not named them.

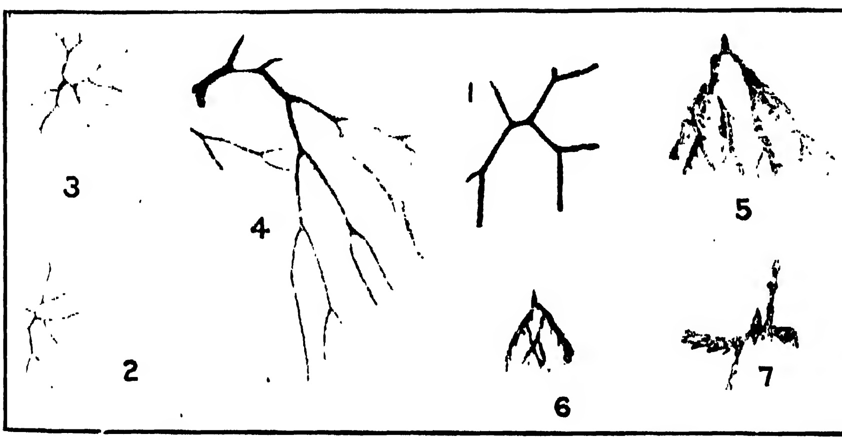
The figures show the following forms:—

Clonograptus tenellus Linnarson.
Clonograptus tenellus var. *callavei* Lapworth.
Clonograptus sp. n.
Bryograptus sp.
Tetragraptus decipiens T. S. Hall.

In addition, there are many fragments, suggestive but unidentifiable. None of these seem to belong to genera not represented at Lancefield. *Clonograptus tenellus* and its numerous varieties is, outside Australasia, a typical Cambrian species.* In Victoria it is, as has been shown, Lower Ordovician.†

The new species of *Clonograptus* is a fairly large one, and a perfect hydrosome would probably be 6 in. or 8 in. in diameter. But there is not enough of it preserved to justify description. *Bryograptus* is represented

* See especially A. H. Westergard, Studier öfver Dictyograptusskiffern, &c. Lunds Universitets Ansshrift. N.F., Afd. 2, bd. 5, nr. 3, 1909.
† T. S. Hall, Proc. Roy. Soc. Victoria, n.s., vol. ii, 1899, p. 164.



GRAPTOLITES FROM WESTERN OTAGO.

by numerous examples which may belong to two species, but they are closely allied. The angle of divergence of the primary branches is smaller than in *B. victoriae* T. S. H., but it is not far removed from that species. *Tetragraptus decipiens* T. S. H. is common, and shown in several of the typical positions which it assumes at Lancefield. Two large specimens are present, but I have not figured them.

Bryograptus, long considered to be confined to Cambrian rocks, has been shown by Ruedemann to range into the Ordovician in New York, just as it does in Australia, while *Tetragraptus* is unknown in the Cambrian.

The age of the graptolites dealt with is much older than that of any of the Lower Ordovician species yet recorded from New Zealand, and the missing zone—the Bendigonian—will probably be found on further search.

EXPLANATION OF PLATE VIII.

Fig. 1. *Clonograptus tenellus.* × 2.
Fig. 2. *Clonograptus tenellus.* × 1.
Fig. 3. *Clonograptus tenellus* var. *callavei.* × 1.
Fig. 4. *Clonograptus* sp. n. × 1.
Fig. 5. *Bryograptus* sp. × 2.
Fig. 6. *Bryograptus* sp. × 2.
Fig. 7. *Tetragraptus decipiens.* × 2.

Art. XLV.—*The Golden Ridge Graptolites.*

By T. S. Hall, M.A., D.Sc., University of Melbourne.

Communicated by Professor P. Marshall, M.A., D.Sc., Otago University.

[*Read before the Otago Institute, 1st December, 1914.*]

[The fossils submitted to Dr. Hall were collected at the Golden Ridge in 1908, and were kept in the School of Mines, Otago University, for four years. From Dr. Hall's report it appears that during this time some of the specimens in different parcels were interchanged. In spite of this misfortune, Dr. Hall's report is of great value, as establishing definitely the relation between the New Zealand graptolites and those of Victoria. It is hoped that further collections will be sent to Dr. Hall shortly.—P. M.]

The graptolites dealt with in the present paper were collected by Professor P. Marshall, Dunedin, some years ago, and I wish to thank him for this opportunity of examining them. The specimens come from three localities —(1) from the tramway half-way between the battery and the Golden Ridge Mine; (2) Butcher's Gully, or Jacob's Ladder, at the head of Malone's Creek; (3) the lowest adit, Golden Ridge Mine.

A map of the district may be found in "New Zealand Geological Survey Bulletin No. 3," new series, 1907, p. 89. A list of graptolites from Slaty Creek, which bounds the Golden Ridge on the east, is given on pp. 34–37 of the same bulletin.

Dr. Ethel M. R. Shakspear (Miss Woods) in "Geological Magazine," 1908, pp. 145–48, gives an account of some graptolites from Slaty Creek, near the Aorangi Mine. Owing to differences in the texture of the rock-specimens, this author was enabled to divide the specimens in two series.

There is a general agreement in the fossils of Dr. Shakspear's collection and the one before me, but owing to an unfortunate accident I have not been able to define the contents of the beds exactly.

None of the specimens were labelled when I received them, but those from each locality were in separate parcels. There was, however, some confusion in the localities. In one instance counterparts were attributed to separate localities, and in two other instances I think that confusion has taken place, though I am unable to distinguish the matrix. The association, however, is not exactly what we know to occur in Victorian strata, unless the two specimens be rejected.

Arranged in descending order, the three localities are placed as follows: (1) Tramway locality; (2) Golden Ridge; (3) Butcher's Gully.

The following species have been identified:—

(1.) *From the Tramway Locality.*

Didymograptus extensus J. Hall.
—— *caduceus* Salter.
—— *bifidus* J. Hall.
Phyllograptus angustifolius J. Hall (?).
Loganograptus logani J. Hall (?).

In Victoria *D. bifidus* is not associated with the large variety or form of *D. caduceus* which occurs in these beds. I therefore regard the single specimen of *D. bifidus*, which has no other fossil on the same slab with it, as wrongly included. There is, so far as I can see, no difference in the matrix, nor, for the matter of that, is there much between that of the three localities. The specimen doubtfully referred to *Loganograptus logani* is very imperfect, but it is probably that species. Its associates, except *D. bifidus*, do not forbid it.

(2.) *From Lowest Adit of Golden Ridge Mine.*

Didymograptus mundus T. S. H. var.
—— *caduceus* Salter.
Tetragraptus serra Brong.
Dichograptus octobrachiatus J. Hall.
Goniograptus cf. *crinitus* T. S. H.
—— cf. *laxus* T. S. H.
Phyllograptus angustifolius J. Hall.
Diplograptus sp.

The counterpart of the slab that contains *D. octobrachiatus* and the two species of *Goniograptus* was included in the collection from the tramway-line, so that their horizon is not quite certain. It is this clear case of confused association that strengthens my idea that two other cases occur as detailed below. *D. mundus* is closely allied to *D. nitidus*.

(3.) *From Butcher's Gully.*

Didymograptus extensus J. Hall (probably introduced).
—— *caduceus* Salter (probably introduced).
—— *bifidus* J. Hall.
Tetragraptus serra Brong. (?)
—— *harti* T. S. H.
—— *pendens* Elles.
Phyllograptus cf. *typus* J. Hall.

The single example of *D. caduceus* is the large form which in Victoria is not found associated with *D. bifidus*, but occurs in higher beds. It has, I think, been included by mistake. *D. bifidus* is very common, and juvenile and well-grown specimens occur. *Tetragraptus serra* agrees with the figures of the form which J. Hall refers to Brongniart's species, and which has been renamed by Miss Elles and Miss Woods *T. amii*. *T. harti* resembles *T. quadribrachiatus* J. Hall, but has only one theca in the primary branch, and is much more slender. The sicula is well shown in the two examples present. *Phyllograptus* cf. *typus* comprises several specimens of lanceolate forms of various sizes.

AGE OF THE BEDS.

Judging by the Victorian standards, and eliminating the two specimens that I regard as intruders, the beds may be arranged in the order given above. They represent the middle and lower series of the Castlemainian. The Bendigonian, characterized by *Tetragraptus fruticosus*, is with us usually only a few feet below the beds corresponding with those of Butcher's Gully, and it would be of interest to see whether this series is not represented in the locality which has yielded the present series of fossils. The presence of Lancefieldian has been proved at Preservation, as shown by a previous paper to the Institute.

For convenience, the Victorian divisions of the Ordovician are here given, especially as a recent work on geology coming from a faulty source gives them wrongly :—

Upper Ordovician.

Lower Ordovician { Darriwillian.
Castlemainian.
Bendigonian.
Lancefieldian.

ART. XLVI.—*Notes on the Soils of the Wairau Plain, Marlborough.*

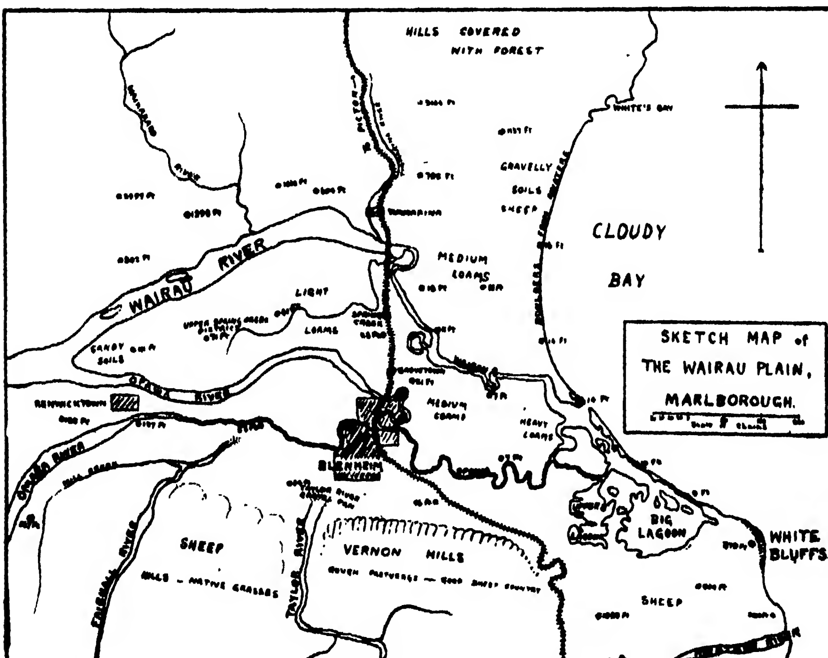
By LEONARD J. WILD, M.A., F.G.S.

[*Read before the Wanganui Philosophical Society, 26th October, 1914.*]

THE district herein described is about 60,000 acres in extent, and includes some of the richest alluvial soils in the Dominion. The Wairau Plain probably owes its formation to the filling-up of a lagoon by the sediments brought down by the Wairau River. There is no doubt that at a geologically recent period this district was at a lower level than it is at present, and what is now a fertile plain was then an arm of the sea extending up the valley for twelve or fourteen miles from the present coast-line. The neighbouring Awatere Valley was also at a lower level, but was nevertheless a land surface, and the Awatere River discharged large quantities of sediment into the sea. A portion of this material, the heavier gravels deposited near the shore, was gradually drifted up the coast, across the mouth of the Wairau arm, and piled up against the cliffs at Cloudy Bay, thus enclosing a lagoon. In this lagoon the sediments of the Wairau River and its present tributaries have been deposited, and even yet the process of filling in is not completed, for in the south-east corner of the district there still remains a portion some

thousand acres in extent, most of it permanently under water, and separated from the sea by a narrow boulder-bank 8 ft. to 16 ft. above sea-level. All the material in this boulder-bank is from the Awatere River, and includes large quantities of the volcanic rocks brought down by the tributaries from the dykes in the Kaikoura Mountains described by McKay, and more recently by Thomson.* The Wairau River, indeed, has not yet carried any gravel to the sea, the limit to which it has so far carried any being just below the railway bridge, which is several miles from the shore-line.

The rivers that cross the plain afford further evidence as to the manner of its formation. The largest, the Wairau, meanders over a wide stretch of country, and provides two very fine examples of an ox-bow curve and one of an ox-bow cut-off. The first curve occurs a little below the point where the Blenheim–Picton Railway line crosses the river, the cut-off is about a mile and a half lower down the river, and the other curve is



about a mile and a half lower down again. The next-largest river, and the most important, in that it makes the Town of Blenheim accessible to small steamers, is the Opawa. This is a distributary of the Wairau, and the two enclose the greater part of the delta formed when the Wairau entered the still waters of the lagoon. The Opawa is a perfect example of a meandering river. The shortest course possible to it from Blenheim to the point where it rejoins the Wairau near the sea is four miles and a half long; the actual course taken by the river in its windings between these two points is over nine miles and a half in length.

These and other facts contribute to an understanding of the geological history of the area. The whole plain is a flat surface slightly tilted towards

* Trans., N.Z. Inst., vol. 45, 1913, p. 308.

the sea. Until the early settlers had considerably increased by artificial means the height of the natural levées bordering the rivers the whole district was subject to periodical floods. Even yet the district is not immune: in December, 1914, a large area was inundated by a Wairau flood, and hundreds of pounds' worth of crops just ready for harvesting were destroyed. Indirectly the floods are useful, for they are active agents in renewing the soil and in building up the plain. Cases have been brought to the notice of the writer of fences built by the settlers of fifty or sixty years ago which are now completely buried by the flood-deposits of less than half a century.

We now have the key to the nature of the soils. Examination in the field and mechanical analysis in the laboratory show that all grades are represented, from gravelly and sandy soils in the inner area to fine-grained silts near the coast. If grouped according to their physical properties, the soils fall roughly into bands parallel to the present coast-line, but there are two notable exceptions to this arrangement. One is the alluvial fan of the Taylor River south of Blenheim, some hundreds of acres in extent. The soil here is gravelly, yet very fertile, and has proved itself capable of maintaining excellent lucerne-fields, and this is no doubt largely due to the excellent drainage and water-supply provided by the widely spreading underground channels of the Taylor River, and to the fact that the area lies well to the sun. The other exceptional area is in the north-east corner of the district, where the band of gravel from the Awatere River already referred to is much wider, as, indeed, it would be expected to be from geological considerations. Here the soils are extremely gravelly, and ploughing has not yet been attempted, but sheep do very well there.

Chemical analyses show that the soils are well stocked with plant-food in an available form, and this is in accord with the remarkable crops they bear. Large yields of excellent malting barley are still obtained, though the yields are not now equal to those obtained by the last generation of farmers. This is generally ascribed to continuous cropping without manures; thorough cultivation is the usual preparation for the crop, and the traditional practice is to "plough three times." The most important crops taken at the present time are oats, barley, peas, clover, lucerne, and such forage crops as rape, mangels, maize, &c., together with a small area of potatoes. The area devoted to roots is necessarily restricted by the scarcity and expense of labour. The fertilizer most commonly used is superphosphate, which even on clovers gives better results than basic slag, notwithstanding that there is not an excess of lime in the soil. The superiority of superphosphate is probably due to its stimulation of root-growth, for the district is one of low rainfall. Nitrogenous and potash manures have been found to produce no appreciable effect.

The Wairau Plain is widely and favourably known for the production of seed of great vitality and high germination-capacity. Thousands of bushels of garden peas are annually exported for seed, and the lucerne seed that gives best results in New Zealand is that grown in Marlborough. A considerable quantity of red clover and cowgrass seed of excellent quality is also harvested, and small areas are given up for the raising of mangel, carrot, and flower-seeds. Seed-raising is for the most part done on the contract system, the farmer supplying the land and labour, and the other party, usually one of the large seed-merchants, providing the seed and taking over the produce at a specified price.

Soil-analyses.

Chemical.

No.	Phosphoric Anhydride (P_2O_5). Citric-acid Extract.	Phosphoric Anhydride (P_2O_5). HCl Extract.	Dipotassic Oxide (K_2O). Citric-acid Extract.	Dipotassic Oxide (K_2O). HCl Extract.	Nitrogen.
1	0·1050	0·2090	0·093	0·323	0·290
2	0·0370	0·1540	0·064	0·470	0·191
3	0·0358	0·1930	0·046	0·426	0·114
4	0·0810	0·1613	0·044	0·415	0·281
5	0·0990	0·1660	0·072	0·515	0·272
6	0·0970	0·1620	0·036	0·340	0·300

Mechanical.

No.	Moisture.	Loss on Ignition.	Clay.	Fine Silt.	Silt.	Fine Sand.	Coarse Sand.	Gravel.
1 ..	2·10	7·90	12·7	45·4	18·2	12·4	1·70	
2 ..	1·90	4·50	1·7	24·3	25·3	23·0	11·70	7·26
3 ..	2·15	5·78	4·6	29·2	25·5	28·0	5·70	
4 ..	1·85	3·85	10·8	20·2	23·7	35·5	5·30	
5 ..	3·12	6·80	5·7	31·4	31·2	17·8	4·35	
6 ..	2·00	4·13	9·8	24·1	26·3	23·6	10·10	

Reference.

At confluence of Wairau and Opawa Rivers.
From Renwicktown.
3. From Blenheim.
4. From Spring Creek, east of railway-line.
5. From Upper Spring Creek.
6. From Upper Spring Creek, west of No. 5.

These analyses were made by the conventional methods of British agricultural chemists. The nitrogen determinations were made by Kjeldahl's method, and the mechanical analyses by the sedimentation process.

ART. XLVII.—*A Commentary on Suter's "Manual of the New Zealand* Mollusca."

By TOM IREDALE.

Communicated by W. R. B. Oliver.

[*Read before the Auckland Institute, 16th December, 1914.*]

THE receipt of the long-looked-for "Manual of the New Zealand *Mollusca*" has given me great pleasure, and I hasten to emphasize my appreciation of Mr. Suter's work, and tender my congratulations to him upon the successful completion of his task and upon the magnificent memorial he has created to his name. I have elsewhere, in another connection, observed the ease of destructive criticism as contrasted with constructive work, and I once more appear in the unhappy *rôle* of a critic who could not have compiled such a work as that subjected to analysis. The part is not a pleasant one, as I well know the disadvantages under which Mr. Suter has perpetually worked in the preparation of his splendid guide, for I once worked at the study of the New Zealand *Mollusca* with no other aid than the Manual compiled by Hutton in 1880. Since then I have enjoyed the benefit of continual access to the unrivalled collections and literature at the British Museum (Natural History), South Kensington, with also daily intercourse with all the well-known British malacologists. Such a contrast has enabled me to realize probably more fully than any other malacologist the wonderful work Mr. Suter has completed.

I have felt compelled to make the preceding remarks, as the following long list of alterations and corrections of Mr. Suter's results might otherwise be misunderstood.

In the present paper the notes are such as I have jotted down while engaged upon the determination of the collection made at the Kermadec Islands during 1908, and also comparison with collections made at Lord Howe Island and Norfolk Island by Mr. Roy Bell.

At the present time I can only indulge in the study of museum collections as regards Neozelanic shells, but the past days of collecting throw many a gleam of light upon the darkness of museum comparisons and dull book-handling.

The majority of the succeeding notes are due to the latter causes, but some field notes also occur. I anticipate, with such an easy guide as that offered by Mr. Suter, a great revival of interest in the field in New Zealand, as there is so much to do. I do know, in my own case, had such a manual been available my own efforts would have been more vigorous and fruitful.

Mr. Suter has omitted the Kermadec *Mollusca*, writing that the Kermadec Islands "belong to a distinct province of the Australian subregion." I am very gratified at this conclusion, which is quite justified, and in agreement with my own results. I hope an account from the pen of my companion, Mr. W. R. B. Oliver, dealing with the Kermadec *Mollusca* as a whole, will succeed this article. Study of it in connection with the Manual will fully confirm Mr. Suter's statement.

Unfortunately, there is one blemish in the Manual, and that is the rejection of names unaccompanied by a figure in favour of later different names proposed with the shell figured. To the systematic worker this is a serious matter, as the International Rules are quite clear upon this point,

and I know of no other recent worker who has followed this practice. In some cases Mr. Suter has given a note remarking his action, but in a few cases he has omitted to do so. In every case, of course, Mr. Suter's action is contrary to the International Rules, and the earliest name must be reinstated.

The succeeding notes are to a great extent nomenclatural, and I want here to emphasize the invaluable aid that the "Index Animalium," by C. Davies Sherborn, must be to the Neozelanic student. Many of the errors here corrected would have been just as easily amended by systematic workers in New Zealand had reference been continually made to Sherborn's priceless work. By means of it they can be practically assured of names prior to 1800.

I am placed in a peculiarly favourable position, as, in addition to the published work, I have access to Mr. Sherborn's continuous labour, and also obtain his unique advice upon bibliographic work. No words can express the gratitude I feel, and it must be understood that many of the following notes are due to Mr. Sherborn's initiative, and depend entirely upon his work, freely given at every opportunity.

I also desire to record the invaluable assistance Mr. E. A. Smith, I.S.O., of the British Museum, has given me. Many of the notes here given are based on his unequalled knowledge of molluscan forms and literature. In every case of doubt I have consulted Mr. Smith, and in no case have I written anything save the results of our considered judgment.

The majority of my notes are novel, but in order that my commentary should cover the recent work done I have included items published by Hedley, Smith, and myself which have appeared since or are not incorporated in the Manual. I give here only those notes which I consider complete at the time of writing—viz., the 15th September, 1914. I mention this as it is certain that some of them will be out of date before publication in June, 1915.

Suter has remarked on p. 941, "I think it is more in the interests of science to separate a number of more or less distinct forms which are produced by differences in their environments. Too much lumping does not tend to advance scientific knowledge." I emphatically endorse this statement, and would apply the principle to the usage of restricted genera and subgenera. I would draw attention to the extraordinary action of British malacologists who, when dealing with Antipodean material, have lumped, as regards genera, in the most casual manner. Yet when classifying the British molluscan fauna, both land and marine, the same workers have utilized to the extreme limit restricted genera and subgenera.

I herewith propose many new groups, which are all the result of study of the Neozelanic forms in conjunction with extra-limital species, and I bleieve the usage of these groups will tend to advance our knowledge.

I have been compelled to make continual reference to my papers in the Proceedings of the Malacological Society of London, where the technical details of the matters are fully discussed. As the Proceedings of this society may not be commonly available throughout New Zealand, I will gladly forward copies of my papers to any reader interested in Neozelanic malacology. Any requests addressed care of British Museum (Natural History), South Kensington, London, S.W., would always reach me.

Some of the succeeding notes may appear rather lengthy, but I have incorporated many extracts explanatory of my conclusions, as I know such cannot be easily referred to, and they will aid the New Zealand worker

in understanding better the results stated. The references given can be quoted freely, as I have carefully verified each one myself.

Order Polyphacophora.

This order has been my chief interest ever since I commenced the study of molluscs. I hope to incorporate all the results of my investigations in a monograph of the Australasian forms. I have, to this end, contributed to the Proceedings of the Malacological Society (London) a series of articles dealing with nomenclatural problems, and also indicating alterations necessary in classification. I herewith give a summary as affecting the names and status of the New Zealand genera and species as I understand them at present. In the "Additions and Emendations," pp. 1077–82, Suter has included some of my earlier notes, so that when considering this group these must be reckoned with. On p. 1082 Suter has given a synopsis of Thiele's classification of these molluscs, a scheme which I generally approve of. I would, nevertheless, indicate that Thiele's arrangement opens up a large field for study, as, though radular characters form the basis of his grouping, shell features confirm it.

Ischnochiton contractus (Reeve, 1847). [P. 8.]*

I have not seen Suter's immature specimen, but I doubt if it should be referred to this species. Mr. W. L. May has sent me specimens of three distinct species which have been confused by Tasmanian collectors under that species-name.

Ischnochiton campbelli (Filhol, 1880). [P. 9.]

On p. 1077 Suter comments upon my identification of *I. fulvus* Suter, 1905, and *I. parkeri* Suter, 1897, with the earlier *Tonicia gryei*, Filhol, 1880, and rejects the last-named, as Filhol's description was unaccompanied by a figure; but Mr. Suter's rejection cannot be maintained. He also differs from me in still considering his own two names as representing distinct species. I have therefore once more re-examined the shells, of which I have long series, and cannot see any differentiating features. Suter only gives "shape and divergence," and in this genus these characters are unstable. Further study of these shells has convinced me that the correct name to be used is as above, based on *Lepidopleurus campbelli* Filhol (Comptes Rendus Sci. Paris, vol. xci, p. 1095, 1880: Campbell Island). When I studied the types of the French authors, by permission of the Curator of the Paris Museum, the types of this species had been mislaid. As the types of *Tonicia gryei* Filhol were hidden under the later name *Lepidopleurus melanterus* Rochebrune, I conclude that the tube so labelled also contained the shells described by Filhol as *L. campbelli*. The description is quite good—indeed, more applicable in detail than that of *Tonicia gryei*, which follows it. Though no figure was offered, this is no reason for dismissing Filhol's name, and I therefore reinstate it as above.

I have seen specimens from South Australia named *I. fulvus* by Dr. Torr, but these are at once recognized as distinct by examination of the girdle-scales. The few deep grooves on the scales of *I. campbelli* Filhol are quite characteristic.

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* The references in square brackets—*e.g.*, [P. 8]—give the page of the "Manual of the New Zealand *Mollusca*" referred to, but the names at the head of the paragraphs in this paper are not always those used by Mr. Suter.

Ischnochiton maorianus Iredale, 1914. [P. 9.]

In the Proc. Mal. Soc. (Lond.), vol. xi, p. 36, 1914, I proposed this name for the common New Zealand species known as *I. longicymba* Quoy and Gaimard, 1835.

In the Dict. Sci. Nat. (Levrault), vol. xxxvi, 1825, Blainville furnished the first systematic monograph of this order, and on p. 542 described *Chiton longicymba* from specimens collected at King Island, Bass Strait. In 1835, as quoted by Suter, Quoy and Gaimard figured a shell under Blainville's name, giving as localities New Zealand and Australia.

In the Manual Conch., vol. xiv, p. 87, 1892, Pilsbry detailed the differences between the shells thus named from Australia and New Zealand, and, ignoring Blainville's name, used Quoy and Gaimard's misinterpretation, further making confusion by restricting the name to the New Zealand form. It is unjustifiable to transfer names in this manner, and the only way out was to name the New Zealand species as I have done.

Acanthochiton australis (Suter, 1907). [P. 16.]

Suter described a *Mopalia australis* from the Snares Islands. Geographically the generic location was extraordinary, and it has now been proved that the genera of Chitons are restricted to certain geographical areas. Thiele, from this reasoning, threw doubt upon the accuracy of Suter's selection. I have been puzzled, but now put forward the solution. The description given by Suter agrees in every detail, save the number of slits in the anterior valve, with *Acanthochiton*. The normal number of slits in that genus is five, and any larger number is due to interslitting. Consequently the eight recorded by Suter is quite abnormal, and misled him owing to the eroded nature of the exterior. Had the sculpture been observed, it is almost certain that the true generic location would have been ascertained at first.

Plaxiphora aurata (Spalowsky, 1795). [P. 18.]

In the Proc. Mal. Soc. (Lond.), vol. xi, p. 31, 1914, I noted that *P. aucklandica* Suter was based upon a juvenile of *P. campbelli* Filhol. I now put forward the above as the correct name for a species which has the longest synonymy of any austral *Chiton*, and yet is the best-marked species.

In the Proc. Mal. Soc. (Lond.), vol. ix, 1910, I synonymized *P. superba* Pilsbry and *P. subatrata* (Pilsbry) Suter with the earlier *P. campbelli* Filhol. These names refer to Neozelanic shells. On the next page I pointed out that *P. carmichaelis* (Wood) should be used for the South American species commonly known as *P. setiger* King, and also recorded as a synonym *C. hahni* Rochebrune. The following year Pilsbry ("Nautilus," vol. xxv, p. 36, 1911) showed that *Chiton auratus* Spalowsky (Prodr. Syst. Hist. Test., p. 88, pl. 13, figs. 6*a*, 6*b*, 1795) antedated both, and though described from "Die Südsee (von der Insel Otahaiti ?)" was undoubtedly the South American shell. I have examined large numbers of the latter in every stage of growth and preservation, and I cannot distinguish any differential characters between them and the Neozelanic shell. It should be remarked that hitherto no one has critically compared the two species. Pilsbry only knew the Neozelanic form from Carpenter's notes, and Suter never mentions the South American species in connection with it. A parallel distributional case is the admission of *Callochiton puniceus* Gould, a common South American shell, to the New Zealand *Chiton* fauna (p. 14). Suter

dismissed *P. campbelli* Filhol for lack of figure (p. 1079), but this excuse cannot be urged against Spalowsky's name, as a beautiful coloured representation accompanies it. I hope to elaborate the relationships of the littoral marine molluscs of South America and New Zealand at some later date, as hitherto not much notice has been given to this fact.

Plaxiphora zigzag (Hutton, 1872). [P. 19.]

Forty-odd years ago Hutton described this species, which has only received its due recognition this year (1914) by myself through indications by Thiele in 1909. In the Revision, p. 23. Thiele's examination of a small shell from Lyttelton led him to point out the differences between this and *P. caelata* Reeve. As the specimen seemed young, Thiele fortunately withheld nomination. When I was collecting at Lyttelton I was always puzzled at the association of all the small *Plaxiphora* under the one name, *caelata* Reeve. A smaller shell, differently coloured, with a peculiar girdle, was more common, but almost always in an unrecognizable state as regards valve sculpture. The larger, clean, easily determined *P. caelata* Reeve lived lower down, and was much more rare. I collected numbers of the former in the desire to secure good-looking specimens. Dissection of many of these showed them constantly to give the characters noted by Thiele as differentiating his unnamed form from *P. caelata* Reeve. In the Proc. Mal. Soc. (Lond.), vol. xi, p. 34, 1914, I recorded the fact that no new name was needed, as this was the species described by Hutton in 1872, and this must be added to the New Zealand list, and the name removed from the synonymy of *P. caelata* Reeve. Hutton's description is very good as regards external features, and the shell can be recognized by means of it.

Suter (p. 1078) remarks that *P. terminalis* may be classed as a subspecies of *P. caelata;* but that conclusion was not intended by my remarks. My reading of Thiele's description and figures of *P. schauinslandi* led me to decide that agreement with *P. terminalis* was certain, laying no weight upon locality. The Chatham Island species, which I have not seen, would appear to differ, though it is difficult to judge from descriptions, and, if so, would bear Thiele's name.

Plaxiphora glauca (Quoy and Gaimard, 1835). [P. 20.]

What the species included under this name is I do not know. It cannot bear this name, as it undoubtedly cannot be the Australian species thus named, for which the correct name is *P. albida* Blainville, as noted by Suter on p. 1079, but rejected as unfigured. "The latter [*glauca* Q. & G.] can still be retained," Suter writes; but that is not so, as the name is preoccupied as corrected by Thiele.

Thiele also named *P. schauinslandi* from the Chathams, and this may be Suter's species. The coincidence of locality and description forces the conclusion, though *P. schauinslandi* is referable to the group I have called *Maorichiton*, while the true *P. albida* is a member of the *Poneroplax* group. I propose to substitute Thiele's name for the doubly invalid one selected by Suter, and ask for confirmation.

I have expressed my views with regard to the genus *Plaxiphora* in the Proc. Mal. Soc. (Lond.), vol. xi, pp. 31–33, 1914, and have separated the species *P. obtecta* Pilsbry, with generic rank. I have distinguished five subgenera in the genus *Plaxiphora*, and would insist upon their usage. This necessitates more careful examination of the species and study of

many dissected examples, but it obviates puzzles such as presented by the record of the species *P. glauca* Q. & G. from the Chatham Islands. The item in Suter's description, "Posterior valve convex, with transverse lines, mucro terminal," suggests its reference to the subgenus *Maorichiton*, and consequently its identity with Thiele's *P. schauinslandi*. The terminal mucro is characteristic of the subgenus, the mucro in Australian shells being never terminal, but subterminal or subcentral.

Genus Acanthochiton (Gray, 1821, em.). [P. 25.]

The introduction of the subgeneric name *Acanthochitona* by Gray in the "London Medical Repository," vol. xv, p. 234, 1821, has been constantly overlooked, the later *Acanthochites* of Risso, 1826, being commonly in use. When I restored it (Proc. Mal. Soc. (Lond.), vol. xi, p. 126, 1914) I also gave notes on the names *Amicula*, *Cryptoconchus*, and *Macandrellus*, and advocated the recognition of four generic types in the Acanthochitons of New Zealand. The synonymy of these names has been discussed in detail at the place quoted, so need not here be elaborated. The family name should be *Cryptoconchidae*, as I noted that *Cryptoconchus* must be regarded as introduced in 1815, and therefore antedates *Acanthochiton* Gray, 1821. I agree with Suter (p. 1080) that *Spongiochiton productus* Pilsbry should be dismissed from the New Zealand list.

Amaurochiton glaucus (Gray, 1828). [P. 34.]

In the "Spicilegia Zoologica," pt. 1, p. 5, 1828, Gray described *Chiton glaucus* from unknown locality. Pilsbry rejected this name, as he considered the description inadequate, and stated that the type was lost. It appears he wrote this last sentence without inquiry, as the type is preserved in the British Museum. Further, Pilsbry based his monograph upon Carpenter's manuscript notes, and Carpenter recognized the type, and upon the back of the tablet is a note by Carpenter regarding his identification. It is undoubtedly the New Zealand shell, and all Neozelanic specimens for many years were, and are still, given Gray's specific name. I simply noted this fact in the Proc. Mal. Soc. (Lond.), vol. xi, p. 38, 1914, in a footnote, when noting the dissimilarity between "*Chiton pellisserpentis* Quoy and Gaimard" and "*Chiton quoyi* Deshayes" = *Amaurochiton glaucus* (Gray). The usage of the generic *Amaurochiton* becomes necessary through the rejection of "*Chiton*" as applicable to a heterogeneous assemblage of Chitons with scaly girdles and pectinated insertion teeth.

Amaurochiton was proposed by Thiele from an examination of the radular characters of Chitons. The name was given to the South American species *C. olivaceus* Deshayes. Thiele also proposed *Triboplax* generically for the present species, but these are only specifically distinct. Indeed, some workers have used the names as if they were conspecific. The relationship is really very close, and there can be no hesitation in using the above generic name. *Chiton* belongs to a species which superficially recalls *Chiton pellisserpentis* Q. & G., and the rejection of it in the present connection will be admitted as necessary by every accurate worker.

Craspedochiton cuneatus (Suter). [P. 42.]

The genus *Tonicia* must be dismissed from the Neozelanic fauna, and the species named by Suter *Tonicia cuneata* transferred to *Craspedochiton*. On p. 1081 Suter records Thiele's conclusion to the same effect from study

of the radula. My own result was achieved by criticism of the shell characters alone. The slitting in the head-valve is abnormal, four only being counted, instead of the usual five, but in *Tonicia* the normal is eight. I would emphasize the fact that the generic location must be regarded as temporary only, as I have not seen the unique specimen, and the figure given by Suter is comparatively valueless, showing seven valves only.

I wish Mr. J. C. Anderson would find some more specimens, but I well know the difficulty of securing these rare stragglers from deeper water.

Genus Acanthopleura (Guilding). [P. 44.]

This, with the species *A. granulata*, and all the matter connected with them, must be omitted, as this is no constituent of the New Zealand fauna. I have pointed out, as acknowledged in the Manual, p. 1078, that *Tonicia corticata* Hutton should rank as a synonym of *Plaxiphora biramosa* (Quoy and Gaimard). The genus *Acanthopleura* is confined to the tropics, rarely occurring outside these limits. It is absolutely littoral in every portion of its range, though sometimes specimens are dredged in shallow water. Two species occur in north Australia and the Pacific Ocean, but it is the West Indian species that is here included. It is impossible to accept such a record, and I do not think that the shell upon which Suter based his record had any history at all. It was certainly never collected alive in New Zealand waters. The locality, Pitt Island, I do not understand, and in view of the known distribution of Chitons this species cannot be recognized as Neozelanic. Will collectors please note.

Onithochiton neglectus (Rochebrune, 1881). [P. 49.]

In the Proc. Mal. Soc. (Lond.), vol. ix, p. 153, 1910, I wrote upon New Zealand Onithochitons, and agreed with Thiele that *O. semisculptus* Pilsbry was an absolute synonym of *O. undulatus* Quoy and Gaimard, and that, moreover, Pilsbry's name was antedated by Rochebrune's four specific names published a dozen years earlier. I also stated that I would consider Suter's var. *subantarcticus* as a different species. In the same journal, vol. xi, pp. 45–46, 1914, I noted that Quoy and Gaimard's name was preoccupied, and that the common New Zealand shell would bear the name *O. filholi* Rochebrune. Upon reconfirming my data I find that this was due to a misreading of my notes, and that the name to be used is *O. neglectus* Rochebrune.

Suter's record of his var. *subantarcticus* from Cook Strait and New Brighton does not refer to this species, which is confined to the subantarctic islands, but belongs to a species quite distinct, but as yet unnamed.

Summaries are most helpful, and I here give a summary of my classification of the Neozelanic *Chiton* fauna, with the use of Thiele's system as basis. I add the original reference only when it differs or is not given by Suter.

Suborder LEPIDOPLEURINA.

Fam. LEPIDOPLEURIDAE Pilsbry.

Genus LEPIDOPLEURUS Risso, 1826.

Subgenus TERENOCHITON Iredale, 1914. *Terenochiton* Iredale, Proc. Mal. Soc. (Lond.), vol. xi, p. 28, 1914. Type: *Lepidopleurus subtropicalis* Iredale.

Lepidopleurus inquinatus (Reeve, 1847).

Suborder CHITONINA.

Fam. LEPIDOCHITONIDAE Iredale.

Genus CALLOCHITON Gray, 1847.

Subgenus ICOPLAX Thiele, 1893. *Icoplax* Thiele, Das Gebiss d. Schnecken, vol. ii, p. 392, 1893. Type: *Chiton puniceus* Gould.

Callochiton puniceus (Gould, 1846). Synonyms: *Chiton illuminatus* Reeve, 1847; *C. dimorphus* Rochebrune, 1889.

—— *sulculatus* Suter, 1907.

—— *empleurus* (Hutton, 1872).

—— *platessa* (Gould, 1846). Synonyms: *Chiton crocinus* Reeve, 1847; *C. versicolor* Angas, 1852.

Genus EUDOXOCHITON Shuttleworth, 1853.

Eudoxochiton nobilis (Gray, 1843).

—— *huttoni* Pilsbry, 1893.

Fam. PLAXIPHORIDAE Iredale.

Genus PLAXIPHORA Gray, 1847.

Subgenus PLAXIPHORA s. str.

Plaxiphora aurata (Spalowsky, 1795). *Chiton auratus* Spalowsky, Prodr. Syst. Hist. Test., p. 88, pl. 13, figs. 6*a*, 6*b*, 1795, "Tahiti" = Falkland Islands. Synonyms: *Chiton carmichaelis* Wood, Index Test. Supp., pl. 1, fig. 10, 1828, "Cape of Good Hope" = South America; *C. setiger* King, Zool. Journ., vol. v, p. 358, 1831, South America; *Plaxifora campbelli* Filhol, Comptes Rendus Sci. Paris, vol. xci, p. 1095, 1880, Campbell Island; *Choetopleura savatieri* Rochebrune, Bull. Soc. Philom. Paris, ser. 7, vol. v, p. 119, 1881, Straits of Magellan; *C. hahni*, id. ib., vol. viii, p. 34, 1884, Patagonia; *C. frigida*, id., Miss. Sci. Cap Horn, vol. vi, Moll., p. 137, 1889, Patagonia; *Plaxiphora superba* Pilsbry, Man. Conch., vol. xiv, p. 319, 1893, New Zealand; *P. subatrata* Suter, Proc. Mal. Soc., vol. ii, p. 188, 1897, New Zealand; *P. aucklandica*, id., Subant. Isds., N.Z., vol. i, Moll., p. 2, 1909, New Zealand.

Subgenus DIAPHOROPLAX Iredale, 1914. *Diaphoroplax* Iredale, Proc. Mal. Soc. (Lond.), vol. xi, p. 32, 1914. Type: *Chiton biramosus* Quoy and Gaimard.

Plaxiphora biramosa (Quoy and Gaimard, 1835). Synonym: *Tonicia corticata* Hutton, 1872.

Subgenus MAORICHITON Iredale, 1914. *Maorichiton* Iredale, Proc. Mal. Soc. (Lond.), vol. xi, p. 32, 1914. Type: *Chiton caelatus* Reeve.

Plaxiphora caelata (Reeve, 1847). Synonym: *Chiton terminalis* E. A. Smith, 1874.

—— *zigzag* (Hutton, 1872).

—— *murdochi* Suter, 1905.

—— *schauinslandi* Thiele, 1909. Synonym: *Plaxiphora glauca* Suter, 1905 (not Quoy, 1835).

Subgenus FREMBLEYA H. Adams, 1866. *Frembleya* H. Adams, Proc. Zool. Soc. (Lond.), 1866, p. 445. Type: *F. egregia* H. Adams.

Plaxiphora egregia (H. Adams, 1866). Synonym: *Acanthochaetes ovatus* Hutton, 1872.

Suborder CHITONINA—*continued.*

Fam. PLAXIPHORIDAE—*continued.*

Genus GUILDINGIA Pilsbry, 1893.

Guildingia obtecta (Pilsbry, 1893). Synonym: *Plaxiphora suteri* Pilsbry, 1894.

Fam. CRYPTOCONCHIDAE Iredale.

Genus CRYPTOCONCHUS Burrow, 1815. *Cryptoconchus* Burrow, Elem. Conch., 1815, p. 190. Type: *Chiton porosus* Burrow. Synonym: *Amicula* Gray in Dieffenbach's "Travels in New Zealand," vol. ii, p. 246, 1843. Type: *C. porosus* Burrow.

Cryptoconchus porosus Burrow, 1815. Synonyms: *Cryptoplax depressus* Blainville, 1818; *Chiton leachi* Blainville, 1825; *C. monticularis* Quoy and Gaimard, 1835; *Cryptoconchus stewartianus* Rochebrune, 1881.

Genus ACANTHOCHITON (Gray, 1821, em.). *Acanthochitona* Gray, Lond. Med. Repos., vol. xv, p. 234, 1821. Type: *Chiton fascicularis* Linné. Synonym: *Phakellopleura* Guilding, 1829.

Acanthochiton zelandicus (Quoy and Gaimard, 1835). Synonym: *Acanthochaetes hookeri* Gray, 1843.

—— *thileniusi* Thiele, 1909.

—— *australis* Suter (1907).

Genus MACANDRELLUS Dall, 1878. *Macandrellus* Dall, Proc. U.S. Nat. Mus., vol. i, p. 299, 1878. Type: *Acanthochites costatus* Adams and Angas. Synonym: *Loboplax* Pilsbry, "Nautilus," vol. vii, p. 32, 1893. Type: *Chiton violaceus* Quoy and Gaimard.

Macandrellus violaceus Quoy and Gaimard, 1835. Synonym: *Chiton porphyreticus* Reeve, 1847.

Macandrellus mariae Webster, 1908. Synonym: *Loboplax stewartiana* Thiele, 1909.

Genus CRASPEDOCHITON Shuttleworth, 1853. *Craspedochiton* Shuttleworth, Mittheil. naturf. Gesell. Berne, p. 67, 1853. Type: *Chiton laqueatus* Sowerby. Synonyms: *Angasia* Pilsbry, Man. Conch., vol. xiv, p. 287 1893 (preocc.). Type: *Angasia tetrica* Pilsbry. *Phacellozona* Pilsbry, "Nautilus," vol. vii, p. 139, 1894. Type: *Angasia tetrica* Pilsbry.

Craspedochiton rubiginosus (Hutton, 1872).

—— *cuneatus* (Suter, 1908).

Fam. ISCHNOCHITONIDAE Thiele.

Genus ISCHNOCHITON Gray, 1847. Type: *Chiton textilis* Gray.

Ischnochiton maorianus Iredale, Proc. Mal. Soc. (Lond.), vol. xi, p. 36, 1914: Otago Peninsula. Synonym: *Ischnochiton longicymba* Pilsbry, 1892 (not *Chiton longicymba* Blainville, 1825).

—— *campbelli* (Filhol, 1880). *Lepidopleurus campbelli* Filhol, Comptes Rendus Sci. Paris, vol. xci, p. 1095, 1880, Campbell Island. Synonyms: *Tonicia gryei* Filhol, ib. id.; *Lepidopleurus melanterus* Rochebrune, Bull. Soc. Philom. Paris, 1883–84, p. 37; *Ischnochiton parkeri* Suter, 1897; *I. fulvus* Suter, 1905.

—— *granulifer* Thiele, 1909.

—— *luteoroseus* Suter, 1907.

—— ? *contractus* (Reeve, 1847) ?

Genus LORICA H. and A. Adams, 1852.

Lorica volvox (Reeve, 1847). Synonyms: *Chiton cimolius* Reeve, 1847; *C. rudis* Hutton, 18[illegible]

Suborder CHITONINA—*continued.*

Fam. CHITONIDAE Thiele.

Genus SYPHAROCHITON Thiele, 1893. *Sypharochiton* Thiele, "Das Gebiss der Schnecken," vol. ii, p. 365, 1893. Type: *Chiton pellisserpentis* Quoy and Gaimard. Synonym: *Triboplax* Thiele, loc. cit., p. 366.

Spharochiton pellisserpentis (Quoy and Gaimard, 1835).

—— *sinclairi* (Gray, 1843).

—— *torri* (Suter, 1907).

Genus AMAUROCHITON Thiele, 1893. *Amaurochiton* Thiele, loc. cit., p. 362. Type: *C. olivaceus* Deshayes. Synonym: *Poeciloplax* Thiele, loc. cit., p. 365.

Amaurochiton glaucus Gray, 1828. *Chiton glaucus* Gray, "Spicilegia Zoologica," pt. i, p. 5, 1828. Synonyms: *C. viridis* Quoy and Gaimard, 1835; *C. quoyi* Deshayes, 1836; *C. quoyi* subsp. *limosus* Suter, 1905.

Genus RHYSSOPLAX Thiele, 1893. *Rhyssoplax* Thiele, loc. cit., p. 368. Type: *Chiton affinis* Issel. Synonyms: *Clathropleura* Thiele, loc. cit., p. 367 (not of Tiberi, 1878); *Anthochiton* Thiele, loc. cit., p. 377.

Rhyssoplax aerea (Reeve, 1847).

—— *canaliculata* (Quoy and Gaimard, 1835). Synonyms: *Chiton stangeri* Reeve, 1847; *C. insculptus* A. Adams, 1854.

—— *clavata* (Suter, 1907).

—— *huttoni* (Suter, 1906).

—— *limans* (Pilsbry, 1893). *Chiton limans* Pilsbry, Man. Conch., vol. xiv, p. 176, 1893. Synonym: *C. muricatus* A. Adams, 1854, not Tilesius, 1824.

—— *suteri* (Iredale, 1910). Synonym: *Chiton stangeri* Suter, 1897, not Reeve, 1847.

Genus ONITHOCHITON Gray, 1847.

Onithochiton marmoratus Wissel, 1904. Synonym: *Onithochiton nodosus* Suter, 1907.

—— *subantarcticus* Suter, 1907.

—— *neglectus* Rochebrune, Bull. Soc. Philom. Paris, ser. 7, vol. v, p. 120, 1881: Wellington, N.Z. Synonyms: *Chiton undulatus* Quoy and Gaimard, 1835, not Wood, 1828; *Onithochiton astrolabei* Rochebrune, loc. cit., p. 120; *O. filholi*, id. ib.; *O. decipiens*, id. ib., vol. vi, p. 196, 1882; *O. semisculptus* Pilsbry, 1893.

There is still much to be done in the investigation of the Neozelanic *Chiton* fauna, as, in addition to the preceding, I have unicums representing two distinct species, and I have two other recognizable species hitherto confused. I have also seen a deep-water *Lepidopleurus* dredged by the Scott Antarctic Expedition.

Fam. Acmaeidae. [P. 62.]

It is doubtful whether this name should be retained, as there is a prior *Acmea* ("Hartmann Neue Alpin," i, 1820) and the two names seem to conflict. I am, however, less concerned with regard to this debatable point after examination of the type species of *Acmaea* Eschscholtz. This is a west North American shell, and the Neozelanic shells are decidedly not

congeneric. When the classification used by Australian and Neozelanic malacologists was prepared scientific investigation as to phylogeny as understood to-day was in its infancy, and geography and much else was disregarded. If a shell resembling *Acmaea mitra* was found by a Neozelanic conchologist, I venture to state it would have been classed anywhere but in *Acmaea*. I am convinced that, though Neozelanic malacology has benefited greatly by the research of American workers, it has also suffered through the acceptance of their conclusions as regards generic and specific values, such conclusions being based on little or no material conjoined to an ignorance of local conditions. From 1880 to 1913 the number of forms recognized was raised from 447 to 1187, and this can be said to be the work of one man, Mr. Henry Suter, for, though much collecting was done by others, the bulk of this was due to Mr. Suter's initiative. The work is just commencing in every way, animals and habits being as yet comparatively unknown.

The rejection of *Acmaea* from the New Zealand list is certainly inevitable, and the other names given to northern "Acmaeas,"—viz., *Tectura* Gray, *Erginus* Jeffreys, and *Collisella* Dall—are just as unsuitable.

From shell characters the Neozelanic species are easily grouped, and there can be little doubt that animal characters coincidently agree. I propose to introduce new names for these, and invite investigation and study. These names are equally applicable to Australian forms, and it should be observed that these austral species have no connection with northern forms, "Acmaeas" being practically absent from the intervening tropics. By the usage of these names we get a better idea of the relationships of the forms than by the continuance of extra-limital terms which are most doubtfully applicable, and which, judging from shell characters, are certainly untenable.

Radiacmea gen. nov. [P. 63.]

I propose this name for the group of shells around *A. cingulata* Hutton, which I name as type. These agree in shape, external features, and general coloration. According to Suter, the radular characters are "typical, resembling very much that of *A. mitra* Esch." With this species the shell has nothing in common. The shells would come nearer *A. corticata* Hutton, but the radula of this species differs. The group is well marked in New Zealand, but I dissociate Suter's *A. intermedia* and *roseoradiata* from it, and restrict it to *A. cingulata* Hutton and *Fissurella rubiginosa* Hutton.

I did not collect any "Acmaeas" at the Kermadecs, nor have I got any from Norfolk Island, nor are there any littoral species from Lord Howe Island, but one small species is commonly dredged. Mr. Oliver has, however, received some specimens of *Radiacmea* from the Kermadecs.

Atalacmea gen. nov. [P. 68.]

I propose this name for the species commonly known as *Acmaea fragilis* Chemnitz. Chemnitz was, however, not a binomialist, and his species-names cannot be accepted. This is undoubtedly true as regards all the preceding ten volumes, but because in the eleventh, where this name occurs, binomials are frequent and polynomials scarcer, such binomials have been commonly preserved. Their rejection is inevitable, and it should be noted that these names do not occur in Sherborn's "Index Animalium." The next name appears to be Lesson's *Patella unguis-almae*, which must come into use.

The anatomy of this species is said to differ little from that of other "Acmaeas." I do not agree with this, as the shell characters differ extraordinarily, and in habits this species is no "Acmaea": its habitat and rapid movements are unique in the family, if it be classed correctly.

Notoacmea gen. nov. [P. 71.]

I name as type *Patelloïda pileopsis* Quoy and Gaimard, and would class under this genus the remaining uncharacterized Neozelanic "Acmaeas." with the proviso that probably more than one generic form is here confused. The type shell conchologically resembles that of *Tectura*, of the Northern Hemisphere, and the southern shells were so placed by Thiele, though differences in the radula were shown. The small "Acmaeas," such as *A. daedala* Suter and *A. parviconoidea* Suter, are easily separated, and might form a subgenus, for which I propose the new name *Parvacmea*, and name *A. daedala* Suter as type.

If the Neozelanic species were collected and examined in connection with the names here proposed it would at once be seen how natural my groups are, and also that the Australian forms fall into order.

Patelloïda (Quoy and Gaimard, 1834). [P. 73.]

The nomination of some shells from the Montebello Islands, Western Australia, allowed me the opportunity of rectifying the nomenclature of the shells grouped about *A. saccharina* (Linné), and I discovered that this name was applicable to the group named by Suter as *Collisellina* Dall, 1871. The type of *Patelloïda* Quoy and Gaimard was given in the Manual Conch. by Pilsbry as *P. fragilis* Q. & G., but that was an error; also one which would not be easily discovered by the Neozelanic worker. These facts were recorded in the Proc. Zool. Soc. (Lond.), 1914, p. 670.

The Neozelanic species would be named *Patelloïda stella* (Lesson, 1831); *P. pseudocorticata* (Iredale, 1908); *P. perplexa* (Pilsbry, 1891).

I will discuss the status of *corticata*, now admitted as a subspecies, and *pseudocorticata* in my next communication, when I will give figures elucidating my species.

Notoacmea suteri nom. nov. [P. 65.]

Acmaea roseoradiata Suter, 1907, is preoccupied by the prior *Acmaea roseoradiata* E. A. Smith (Journ. Conch., vol. x, p. 106, pl. i, fig. 19, 1901). I had intended that such alterations should have been made by Mr. Suter himself, but as he has written me to the effect that he will be unable to give more attention to the Recent *Mollusca* in the future I herewith propose amendments. Mr. Suter comments: "This pretty little shell is well characterized, and quite distinct from all other known New Zealand species of the genus." I therefore introduce the above as a suitable alternative. I do not, however, class the species in my genus *Radiacmea*, though Suter associated it with *A. cingulata* Hutton. The radular characters are unknown, and the shell differs appreciably to me from *Radiacmea*. Its reference to *Notoacmea* is, however, of a temporary character.

Notoacmea helmsi (E. A. Smith, 1894). [P. 69.]

Under this name I include the shells referred to *Acmaea septiformis* Quoy and Gaimard by Suter, and also class as a variant the var. *leucoma* Suter, 1907, which he referred to *A. parviconoidea*. Only two localities

are quoted by Suter for *A. helmsi*—viz., Greymouth and Cape Egmont. Examination of the types, however, show it to be a common shell occurring at many points from Lyttelton to Dunedin, and which I had so identified, but ranked as a variety of *A. septiformis* Q. & G. I would reject this latter from the Neozelanic list, as it seems to be the Australian representative of the Neozelanic *A. pileopsis* Quoy and Gaimard. The two species seem liable to extraordinary variation, due to environmental stresses, and really many well-differentiated forms should be recognized in both species. The Australian *septiformis* runs into the form called "*cantharus*," quite wrongly according to my investigations; and at Caloundra, Queensland, I collected two fine shells which immediately recalled large *pileopsis*: they were less elevated, more rounded in outline, and rayed with white rather than spotted; internally they showed the same black edging and light inside coloration. If the Neozelanic and Australian forms be considered separately, and the variation of each carefully studied, much more good would be effected. It does not seem possible with the present material to class *helmsi* as a variant of *pileopsis*, so that a good deal of collecting must be done before much advance can be made in this family. One point I would emphasize is that, from any given place, series of these shells are fairly constant according to their environment.

Notoacmea pileopsis (Quoy and Gaimard, 1834). [P. 71.]

Through usage of alphabetical sequence *Acmaea cantharus* (Reeve) appears five pages away from *Acmaea pileopsis* (Q. & G.). In life there is no such separation. My conclusions put forward in Trans. N.Z. Inst., vol. xi, p. 367, 1908, regarding the identity of these two are therefore not accepted. Further study has not occasioned the revision of my facts, and I would note that since I wrote I have seen that Pilsbry ("Nautilus," vol. viii, p. 127, 1895) had recognized the Tasmanian shell as the true *cantharus* Reeve, quoting that Hutton had previously so decided. Pilsbry, however, has never seen Reeve's types, which I have now examined, and I find they are undoubtedly the Neozelanic shell upon which my conclusions were framed. I had thought that it might be possible to rank *cantharus* Reeve as the southern geographical representative of the northern *pileopsis*. I find that this is impossible, as, though Quoy and Gaimard gave as localities Bay of Islands and French Pass, they described and figured a shell quite like *cantharus*. Suter's recognition of both species at the Auckland Islands necessitates the rejection of specific distinction; and, finally, the name *cantharus* is predated.

Patella sturnus Hombron and Jacquinot (Ann. Sci. Nat., 2nd ser., vol. xvi, p. 191, 1841) refers to this species, and as the description applies to the *cantharus* form, and the type was almost certainly collected in Otago, where *cantharus* is abundant, it would have to come into use. It is somewhat remarkable that, while this name passed into the synonymy of *P. radians* Gmelin, the succeeding *Patelloides antarctica* was correctly placed under the present species.

Patella floccata Reeve. [P. 71.]

This name has continually given trouble, and its last resting-place is in the synonymy of *Acmaea pileopsis* Q. & G. I have carefully examined the types of this species, and would suggest it is not a New Zealand shell at all. It is not, from shell characters, an "*Acmaea*" at all, but belongs to the family *Patellidae*.

Patelloïda perplexa (Pilsbry, 1891). [P. 75.]

This is the only species of "*Acmaea*" or limpet at present commonly acknowledged as specifically identical in Australia and New Zealand. Pilsbry's name was given to an Australian shell, and comes into use, as Hutton, who first described it from New Zealand, unfortunately selected a preoccupied name.

A summary of my classification of the New Zealand "*Acmaeidae*" would read,—

Genus RADIACMEA nov.
Radiacmea cingulata (Hutton, 1883).
—— *rubiginosa* (Hutton, 1873).
Genus ATALACMEA nov.
Atalacmea unguis-almae Lesson. Synonyms: *Patella fragilis* Chemnitz, 1795 (non-binomial); *Patelloïda fragilis* Quoy and Gaimard, 1834; *Patella solandri* Colenso, 1844.
Genus NOTOACMEA nov.
Notoacmea campbelli (Filhol, 1880).
—— *daedala* (Suter, 1907).
subsp. *subtilis* (Suter, 1907).
helmsi (E. A. Smith, 1894).
var. *leucoma* (Suter, 1907).
intermedia (Suter, 1907).
parviconoidea (Suter, 1907).
subsp. *nigrostella* (Suter, 1907).
—— *pileopsis* (Quoy and Gaimard, 1834). Synonyms: *Patella sturnus* Hombron and Jacquinot, 1841; *Patelloides antarctica*, id. ib.; *Patella cantharus* Reeve, 1855.
Notoacmea scapha (Suter, 1907).
—— *suteri* nov. Synonym: *Acmaea roseoradiata* Suter, 1907, not Smith, 1901.
Genus PATELLOÏDA Quoy and Gaimard, 1834. Synonym: *Collisellina* Dall, 1871.
Patelloïda stella (Lesson).
—— —— subsp. *corticata* (Hutton, 1880).
—— *pseudocorticata* (Iredale, 1908).
—— *perplexa* Pilsbry (1891). Synonym: *Patella octoradiata* Hutton, 1873, not Gmelin, 1791.

Genus Cellana (H. Adams, 1869). [P. 78.]

In the synonymy of *Helcioniscus* Dall, 1871, is placed "*Cellana* H. Adams, P.Z.S., 1869, 274; type, *Nacella cernica*, H. Ad." In the Man. Conch., vol. xiii, 1891, Pilsbry (pp. 149–50) noted: "This species is the type of H. Adams's subgenus *Cellana*. It probably belongs to *Helcioniscus* rather than to *Nacella* or *Patinella*. The name *Cellana* has priority over *Helcioniscus*, but it has not been adequately defined."

Under the present laws governing nomenclatural usage the lack of definition does not invalidate a generic name, and consequently *Cellana* must displace *Helcioniscus*. *Helcioniscus* was only provisionally introduced by Dall, who was unaware of H. Adams's *Cellana*.

Pilsbry, in this volume of the Man. Coch., did not use names for Acmaeas and limpets in accordance with the rules now in use, and many alterations are now necessary.

Patella antipodum (E. A. Smith, 1874). [P. 79.]

Suter has made use of this name for the species known in New Zealand as *Helcioniscus tramosericus* Martyn. This name having been questioned as doubtfully applicable to the Australian shell, and *P. diemenensis* Philippi used instead, upon Dall's advice Suter utilizes the present name as obviating discussion, being certainly referable to the New Zealand form, whether this be the same or different from the Australian species. It is regrettable that such a pretty argument should be entirely spoilt by the fact that Smith's name is not available. Almost the first shell I noted in the British Museum was this species, and I was surprised—as most conchologists will be when they read this note—to recognize in it a commonplace variation of *Patella radians* Gmelin. In view of its usage by Suter I have consulted Mr. Smith, the author of the species, and he agrees that his *P. antipodum* could be easily classed as a variant of Gmelin's *P. radians*, while he emphasizes the fact that it has no relationship with the Australian shell known as *H. tramosericus* Martyn. Of this I collected a long series, showing variation and growth stages, at Caloundra, Queensland. None of these exactly agree with Martyn's figure.

I have seen no Neozelanic specimens, so cannot say whether they differ or not. I would certainly endorse Suter's remark, "Species of the *Patellidae* have usually a very limited range of distribution." Suter has not described his Hauraki Gulf specimen, but reprinted E. A. Smith's account of his *P. antipodum*, and, as this refers to a different species, there is no description on record of Neozelanic "*tramosericus*."

With regard to the Australian "*tramosericus*," if Martyn's name be rejected the earliest recognizable name is *Patella variegata* Blainville (Dict. Sci. Nat., vol. xxxviii, p. 101, 1825: Botany Bay). This name is, however, preoccupied by Gmelin, so that choice then falls upon *Patella jacksoniensis* Lesson, Zool. Voy. "Coquille," vol. ii, p. 418, 183: Port Jackson, New South Wales. Both these names were rejected by Pilsbry, but any one acquainted with Australian limpets can recognize them with ease. Blainville described half a dozen other limpets at the place quoted, from Australia, and it is just possible that one of these names may also apply; but I hope to elaborate this in another place. This will suffice to show that it is even probable that a name may exist for the Neozelanic "*tramosericus*," though I think not.

Cellana denticulata (Martyn, 1784). [P. 80.]

In his distribution of this species Suter observes, "Hutton also mentions Dunedin and the Chatham Islands." It is pretty certain that Hutton, mainly dependent upon second-hand information, did not recognize our names for the forms accepted. Thus in 1907 I made notes upon the Otago Museum shells, and I observed that under the name *P. denticulata* specimens were shown from Moeraki and Nelson; but these were not that species, but *C. ornata* Dillwyn. I do not know who was responsible for the incorrect nomination, but the adjacent shells were true *C. denticulata* Martyn, and these bore the data "*H. strigilis* var. *redimiculum*, North Island, F. W. H." I should conclude this merely meant that Hutton collected or presented these specimens, but he may also have specifically determined them.

Cellana radians (Gmelin, 1791). [P. 81.]

It may be as well to record that the date of Gmelin's Mollusca is given throughout Suter's work as 1790, whereas it should be 1791 (Hopkinson, P.Z.S., 1907, p. 1035), the earliest date of notice being the 14th May, 1791

First, omit from the synonymy "*P. sturnus*, H. & J., t.c., 191" (a synonym of *N. pileopsis* Q. & G.); and add, "*Patella antipodum* E. A. Smith, Voy. Ereb. & Terr., Moll., p. 4, pl. 1, f. 25, 1874." The forms of this species recognized by Suter I cannot consider well defined.

Patella argentea Quoy and Gaimard, 1834, is untenable through *Patella argentea* Gmelin, Syst. Nat., p. 3704, 1791; also *Patella affinis* Reeve, 1855, by *P. affinis* Gmelin, loc. cit., p. 3726, and *Patella olivacea* Hutton, 1882, by the use of *P. olivacea* Gmelin, loc. cit., p. 3702.

For Hutton's *P. olivacea* I propose the new name *Cellana radians perana*, and would unite with it the so-called "*argentea*."

Suter has reduced to subspecific rank under this species the shell he described as *Helcioniscus mestayerae*. This is not a New Zealand shell. It was supposed to have come from Stewart Island, but when Miss Mestayer showed me the type in 1908 I at once remarked upon its alien features. Miss Mestayer concurred, and suggested that the locality was incorrect. A few days later, at Sydney, Mr. Hedley gave me a specimen agreeing entirely, naming it as *Patella testudinaria* Linné. Into the synonymy of this exotic species, then, must pass *Helcioniscus mestayerae* Suter: Stewart Island (error); and it must be expunged from the Neozelanic list.

Cellana strigilis (Hombron and Jacquinot, 1841). [P. 87.]

I cannot separate, even as a variety, *Patella redimiculum* Reeve, which Suter admits as a distinct species, writing, "The two are very nearly allied." At Shag Point, Otago, I collected a long series showing gradation from the one to the other. Only one species is admitted in the British Museum. The variation in the species is really slight, and when the two forms are studied in life it is easily seen that the elevation or depression is due to environmental stress. At a point in Dunedin Harbour, Otago, I procured many specimens of typical "*strigilis*," leaving no doubt as to their development by stress, as the juveniles were quite typical "*redimiculum*."

Suter records both species from Preservation Inlet, and his measurements of the "*redimiculum*" shell agree almost with a "*strigilis*" from Tauranga to a millimetre—viz., 58 × 47 × 23 mm. and 60 × 48 × 24 mm.

My arrangement of the species of *Cellana* would be,—

Genus Cellana H. Adams, 1869. Synonym: *Helcioniscus* Dall, 1871.
Cellana sp. ?? Synonym: *Helcioniscus antipodum* Suter, not Smith.
—— *denticulata* (Martyn, 1784).
—— *ornata* (Dillwyn, 1817).
—— *radians* (Gmelin, 1791).
—— —— var. *decora* (Philippi, 1848).
—— —— var. *earlii* (Reeve, 1855).
—— —— var. ? *chathamensis* (Pilsbry, 1891). Synonym: *affinis* Reeve, 1855, not Gmelin, 1791.
—— —— var. *flava* (Hutton, 1873).
—— —— var. *perana* nov. Synonyms: *olivacea* Hutton, 1882, and *argentea* Quoy and Gaimard, 1834, not Gmelin, 1791.
—— *strigilis* (Hombron and Jacquinot, 1841). Synonym: *P. redimiculum* Reeve, 1854.
—— *stellifera* (Gmelin, 1791).
—— —— var. *phymatia* (Suter, 1905).

A most delightful field of study here reveals itself, as the species and varieties are repeated throughout the Dominion, and there must be a

recognizable cause for the repetition of distinct forms in separate localities. An easily determined form is *Cellana radians* var. *flava* Hutton. This beautiful shell is common at Napier, and lives upon the red sandstone rocks, into which it makes hollows, so that it is difficult to detach without cutting the rock away. Upon the black hard rocks intermingled dark shells are found, and I believe that this yellow form will only be obtained when the soft red rocks are available for its development. Perfectly coloured shells are rare, as might be anticipated.

Montfortula gen. nov. [P. 100.]

Under the genus-name *Subemarginula* Blainville, 1825, three New Zealand species are named, two sections being admitted. This nomenclature and classification is incorrect, though Suter is not to blame in the matter, as he simply followed the "Manual of Conchology," wherein the species of this family were monographed by Pilsbry twenty-odd years previously. It is quite remarkable that no corrections have been made since Pilsbry's work was published, and it has apparently been accepted by most workers without question.

Firstly, the genus-name *Subemarginula* Blainville, 1825, was accepted. Upon reference to the place quoted (Man. Mal., p. 501, 1825) the name does not occur, but there is only a section of the genus *Emarginula* named "Les Subémarginules." Such an introduction of a vernacular is not recognizable, and it was necessary to trace the first user of the latinized form *Subemarginula*. This search resulted in Gray, Proc. Zool. Soc. (Lond.), 1847, p. 147; type, *Patella octoradiata* Gmelin. This is not the type named by Pilsbry—viz., *Emarginula emarginata* Blainville—but there is no question that *Subemarginula* must date from Gray, 1847, with *Patella octoradiata* Gmelin as type, upon the present facts. *Hemitoma* Swainson ("Treatise Malacology," pp. 244, 356, 1840), with *H. tricostata* Sw., Sow. Gen., fig. 6, was the next synonym, but this appeared to be preoccupied by *Hemitoma* Rafinesque, 1820. Rafinesque, however, proposed *Hemiloma*, and *Hemitoma* was only one of Agassiz's gratuitous manuscript corrections ? quoted by Scudder. This species is congeneric with Blainville's *E. emarginata*, and would be the earliest name for the association grouped by Pilsbry under "*Subemarginula*."

At this point it became necessary to study the shells, which I casually knew, more carefully, to determine the groups, as it became obvious Pilsbry's grouping was faulty.

Clypidina Gray, 1847, was used by Suter as the sectional-name for "*rugosa* Quoy and Gaimard." I collected many specimens of this shell at Sydney, New South Wales, and Caloundra, Queensland. I also procured examples of *Patella notata* Linné at Colombo, Ceylon. This shell is the type of *Clypidina* which was introduced by Gray in the Proc. Zool. Soc. (Lond.), 1847, p. 147. These are entirely different in every manner, and do not show the "internal groove distinct, ending in a short anterior notch," which is given by Suter as the character of the section. The groove is so indistinct that very recently specimens of this Linnean species (Syst. Nat., ed. x, p. 784, 1758) were determined by a well-known conchologist as a new species of *Acmaea!* This memo should indicate how unlike *Clypidina* is to the other "subemarginuloid" shells. I regard this as a distinct monotypic genus, and it is so classed in the British Museum.

I also consider *Tugalia*, notwithstanding Pilsbry's opinion, should also rank as a distinct genus, the animal as well as the shell showing good

differential characters. Again, the British Museum classification is in agreement with my own conclusion. The first reference is that in Dieffenbach's "Travels in New Zealand," vol. ii, p. 259, 1843, where the name is written *Tugali.* I see with regard to both this reference and that of *Clypidina* that Suter gives Syst. Dist. Moll. Brit. Mus., though quoting dates correctly as 1843 and 1847 respectively. The book quoted did not appear until 1857. Such action is most confusing, as Suter gives the second reference in his specific synonymy.

Under the genus-name *Hemitoma* Swainson, 1840, a series of shells is arrayed in the British Museum (the genus-name *Subemarginula* not being recognized) which can be easily divided into three groups. No intermediates occur in any way, so that these should be regarded as genera. Examination of the radula will confirm this. The first group consists of *Patella octoradiata* Gmelin alone, and for this *Subemarginula* Gray, 1847, must be used. The second, typified by *tricostata* Swainson, must bear the name *Hemitoma* Swainson, 1840. The names, in the British Museum, associated with species congeneric with this shell are *australis* Quoy and Gaimard, *sculptilis* A. Ad., *panhi* Quoy and Gaimard, *panhiensis* Reeve, *imbricata* A. Ad., *guadaloupensis* Sowerby, *polygonalis* A. Ad., *nodulosa* A. Ad., and *oldhamiana* G. and H. Nevill. Some of these may be synonyms, and I simply quote them to show the extent of the group and the ease with which species may be determined. To this genus must be assigned *Emarginula emarginata* Blainville, but this specific name is generally abandoned as indeterminable. I would observe that Blainville appears to have previously described this species in the Dict. Sci. Nat. (Levrault), vol. xiv, p. 382, 1819, under the name *Emarginula subemarginata*, but here also the description is indeterminate.

The third group is represented in the British Museum by shells bearing the names *rugosa* Quoy and Gaimard; *candida*, *annulata*, and *stellata*, all of A. Adams; and *fungina*, *aspera*, *radiata*, and *cinerea*, all of Gould. Again, these contain recognized synonyms, but probably other district species could be added. This is the group occurring in the Neozelanic fauna, and it was necessary to find a name for it.

As a synonym of *Subemarginula*, Pilsbry included *Siphonella* Issel, but on p. 284 he dismissed the species thus: "*S. arconatii* Issel (Mal. Mar. Ross., p. 232). Unfigured. Gulf of Akaba." This was easy, but quite unscientific, for on reference to Issel's work I find a long, careful description given, and the group to which the shell belonged is easily determined by the characters, "Testa solidiuscula, capuliformi . . . costis 3 anticis productioribus, media maxima, intus laevi, canali profundo antice munita; apice subcentrali recurvo." *Siphonella* Issel, 1869, thus becomes a synonym of *Hemitoma*; but the name is also preoccupied. As the name of a section, Pilsbry used *Plagiorhytis* Fischer (Man. Conch., p. 860, 1885), and thereto added only *stellata* A. Ad. and *sulcifera* A. Ad. When Fischer proposed this name he regarded *S. rugosa* Quoy and Gaimard as typical of *Subemarginula* Blainville, 1825 = *Hemitoma* Swainson, 1840 = *Montfortia* Récluz 1843 = *Siphonella* Issel, 1869. His definition of *Plagiorhytis* reads, "Rigole oblique et dirigée un peu à droite (*S. stellata* A. Adams)." It would seem, then, that Fischer intended to name the "*emarginata* Blainville" group, but the species named is referable to the "*rugosa*" group. Neither Fischer nor Pilsbry had ever seen Adams's types of *stellata*. Fortunately we are relieved from the decision of fixing Fischer's name, as it is invalid, being preoccupied. In the synonymy Fischer has given "*Montfortia* Récluz,

1843," a name for some unknown reason quite ignored by Pilsbry. In the Revue de Zool., 1843 (Sept.), p. 259, Récluz diagnosed a group and named it "*Montforti* (Nobis). Les Subémarginales Blainville." He wrote, "De cette section . . . nous connaissons six espèces . . . *Em. emarginata* Blainv., *Em. panki* [sic] Quoy, *Em. australis* Quoy, *Em. tricostata* Sow. (*Patella tricostata* Gmelin), *Em. depressa* Blain. et la suivante . . . Nous proposerions de donner à ce nouveau genre le nom de *Montfortia* en l'honneur de Denis de Montfort." On p. 376 the first line given in corrected to "*Montfortia* (Nobis). Les Subémarginules (Blainv.)." I designate as type *E. australis* Quoy and Gaimard, as the Blainvillean species are doubtfully determined; Récluz's species are all congeneric, and the name falls as a synonym of *Hemitoma*.

I have therefore failed in my search for a name for the "*rugosa*" group, and therefore propose the new generic name *Montfortula*, with *Emarginula rugosa* Quoy and Gaimard as type. My study of the shells available at the British Museum, and my knowledge of the live animals of *M. rugosa* (Q. & G.), with species of *Emarginula*, leads me to state that there is a greater alliance between species of *Montfortula* and *Emarginula* than between *Montfortula* and *Hemitoma*, whilst *Subemarginula* Gray, 1847, I suggest differs greatly. As a matter of fact, it is quite probable that study of the shells classed under *Emarginula* would cause the degradation of *Montfortula* to subgeneric rank under that genus. I have to consider many species of *Emarginula* in the Lord Howe Island fauna, when I will carefully deal with that aspect of the case.

The alterations necessary may be summarized thus: Omit *Subemarginula* Blainville, 1825, with its synonymy, and *Clypidina* Gray with its reference, and read,—

Genus MONTFORTULA nov.
Montfortula rugosa (Quoy and Gaimard, 1834).
Genus TUGALIA Gray, 1843, em.
Tugalia parmophoidea (Quoy and Gaimard, 1834).
—— *intermedia* (Reeve, 1842).

The synonyms given under *M. rugosa* Q. & G. may not be all correct, but I will attend to those later.

With regards to *Tugalia intermedia* (Reeve, 1842), Suter says, "The type is from Port Jackson." In the original description, however, the locality given is "I. of Bohol, Philippines." The type should be in the Mus. Cuming, preserved in the British Museum, but I have not yet traced it. I mention this as there are Philippine species of this genus.

Genus Trochus (Linné, 1758). [P. 106.]

The classification utilized by Suter is that put forward by Pilsbry in the "Manual of Conchology" twenty-odd years previously, and is one which, as regards generic and subgeneric values, has been discarded for many years even by Pilsbry himself. No recent malacologist, however conservative he may be, sinks *Clanculus* as a subgenus of *Trochus*. A criticism of the series presented in the British Museum shows the species generally classed under *Trochus* to resolve themselves into three distinct rather large groups and several distinct smaller ones.

The generally accepted type of Linné's *Trochus* I have shown to be untenable, as it does not occur in the Linnean genus, and therefore to cause the least confusion I designated as type of *Trochus* Linné (Syst. Nat., ed. x,

p. 756, 1758) the species *Trochus maculatus* Linné (Proc. Mal. Soc. (Lond.), vol. x, p. 225, 1912).

The genus *Tectus* Montfort is well defined and limited, and does not occur on the mainland of New Zealand, but the shell I described from the Kermadecs as *Trochus royanus* (Proc. Mal. Soc. (Lond.), vol. x, p. 225, pl. ix, fig. 12, 1912) must be called *Tectus royanus* (Iredale).

Infundibulum Montfort does not easily fall into any other group, and should be generically recognized, but no members are Neozelanic. *Cardinalia* Gray constitutes another distinct little group, whilst *Trochus niloticus* cannot be easily lumped.

The majority of the other species can be classed around *Trochus maculatus* Linné, the type of *Trochus* Linné, 1758, of which *Lamprostoma* Swainson, 1840, is an absolute synonym. Fischer's *Coelotrochus* and Gray's *Anthora* seem merely sections of this genus, and scarcely seem worth recognition. The species seem to grade very easily. If the section "*Anthora*" be retained, a good excuse being the thickened outer lip, a rather infrequent occurrence in the genus, it must be renamed, as *Anthora* Gray is preoccupied. The new name *Thorista* can be used. The species *Polydonta chathamensis* Hutton, 1873, does not fall into any known Trochoid group, and it is worth while noting that the species is placed under the genus *Gibbula* (sensu latissimo) in the British Museum. Suter has associated subspecifically the shell he described as *Trochus oppressus* var. *dunedinensis*, and "*Trochus*" *oppressus* was described by Hutton under the genus name *Gibbula*. To fix the valid nature of this group it is only necessary to state that on p. 144 Suter has included the species described by E. A. Smith as *Calliostoma aucklandicum* in the genus *Calliostoma*, with the remark, "I have not seen this species." Examination of the types of Smith's species show them to be very close allies of "*chathamensis*," and I see that in the "Hab." of that species "Auckland Islands (Captain Bollons)" occurs. Specimens from Snares in 50 fathoms (Captain Bollons) and Bounty Islands in 50 fathoms (Captain Bollons) appeared to agree with the Auckland Island shell. From the series here available, I conclude the two forms are distinct, and the above localities should be transferred from "*chathamensis*" to "*aucklandicum*."

Inasmuch as the three selections *Trochus*, *Gibbula*, and *Calliostoma* are each unsuitable, and show the peculiar nature of the shells, I introduce the new genus *Thoristella*, and designate *Polydonta chathamensis* Hutton, 1873, as type. The subfamily name is spelt in error on p. 106 "*Trochininae*"; it should be "*Trochinae*." *Trochus* will be retained, as the New Zealand species are congeneric with *T. maculatus* Linné.

The names to be used would be,—

Genus Trochus Linné, 1758.

Section *Coelotrochus* Fischer, 1880.

Trochus tiaratus Quoy and Gaimard, 1834.

Section *Thorista* nov. = *Anthora* Gray preocc.

Trochus viridis Gmelin, 1791.

—— *camelophorus* Webster, 1906.

Genus Thoristella nov.

Thoristella chathamensis (Hutton, 1873).

—— —— var. *dunedinensis* (Suter, 1907).

—— *aucklandica* (E. A. Smith, 1902).

—— *oppressa* (Hutton, 1878).

Genus CLANCULUS Montfort, 1810.
Clanculus ringens (Menke, 1843).
—— *takapunensis* (Webster, 1906).

Section **Melagraphia** (Gray, 1847). [P. 115.]

This name must displace *Neodiloma* Fischer, 1885. It appears to have been quite overlooked, as it appears in no recent synonymy I have examined, nor is it included in Scudder's Nomenclator. It is introduced in the Proc. Zool. Soc. (Lond.), 1847, p. 145, as of "Stentz, 1836," for *Tr. aethiops* Gmel. alone. I have been quite unable to trace any publication by Stentz, and have concluded its reference to Stentz implies manuscript usage only. I observed Philippi referred to other names given by Stentz in manuscript to shells in the Berlin Museum.

Labio concolor (A. Adams, 1853). [P. 116.]

Eliminate this name from the synonymy of *Monodonta aethiops* Gmelin, 1791, as examination of the types, preserved in the British Museum, show the locality given to be incorrect, the shells being a form of *Trochus lineatus* Da Costa, a shell I have collected at Torquay, England.

Labio rudis (A. Adams, 1853). [P. 117.]

This is the earliest name given to the "*corrosa*" group by A. Adams, the locality "Australia" being incorrect. It has one page priority over *L. corrosa*, but the name is invalidated by the prior *Mondonta rudis* Gray in King's Survey Coasts Austr., App., p. 480, 1826, which appears to me to be identical with and have priority over the Western Australian *melanoloma* Menke. It is possible that *Labio rudis* has been placed in the synonymy of the Western Australian species, but examination of the types show them to be the commonest form of *corrosa*," such as is easily collected in the Heathcote Estuary, Christchurch.

Trochus acuminatus (Perry, 1811). [P. 124.]

This synonym of *Cantharidus opalus* Martyn, 1784, is not included by Suter. In Perry's "Conchology," pl. xlvii, fig. 1, an easily recognizable figure is given.

Cantharidus capillaceus (Philippi, 1848). [P. 125.]

Suter has used the later *C. pruninus* Gould, 1849, though including the present name in the synonymy. In the Man. Conch., 1st ser., vol. xi, p. 122, 1889, Gould's name was preferred, but that was due to a mistake in dates, the Otia. Conch., p. 55, being quoted as "1846," though the earliest publication of the name is that given by Suter, and the date 1849 is correct.

Cantharidus capillaceus subsp. **perobtusus** (Pilsbry, 1889). [P. 125.]

Omit from the "Hab." "Sandfly Bay, Otago Peninsula (T. Iredale)." That refers to the shell I described as *Photinula decepta*, which was named as above by Mr. Suter.

Cantharidus capillaceus var. minor (E. A. Smith, 1902). [P. 125.]

From examination of the types, I believe this to be a distinct species, which I will deal with later.

Cantharidus oliveri nom. nov. [P. 126.]

I propose this name for the species described by Suter under the name *Cantharidus pupillus* Hutton, 1884. Hutton did not describe this shell as a distinct species, but simply made use of Gould's name. This misinterpretation cannot be utilized as the basis of a name: this law has been universally accepted, and Suter has constantly admitted it.

Hedley wrote his conclusion thus (Proc. Linn. Soc. N.S.W., vol. xxxiv, p. 436, 1909): "Born never proposed his *Patella tricarinata* as a new species, so that when it is accepted that he did not treat of the Linnean *P. tricarinata* his name has no standing in literature." In case I have no other opportunity, I would point out that the name selected by Hedley on that occasion—viz., *Emarginula clathrata* Adams and Reeve, 184 —is antedated by Deshayes's usage (Ency. Meth. Vers., ii, p. 111, 1830).

I name the *Cantharidus* after my friend Mr. W. R. B. Oliver, who accompanied me on my many collecting trips in New Zealand.

Cantharidus lineolaris (Gould, 1861). [P. 130.]

Hedley (Proc. Linn. Soc. N.S.W., vol. xxxiii, p. 466, 1908) has shown that this name, published in the Proc. Bost. Soc. Nat. Hist., vol. viii, p. 14, 1861, has priority over H. and A. Adams's name *picturatus* of 1863. If the locality "Stuart Island" be the only one known, it would seem to be a doubtful constituent of the New Zealand fauna. The sections *Bankivia*, *Leiopyrga*, and *Thalotia* would be best treated as genera; but I hope to deal with the species of *Cantharidus* at a later date. *Thalotia* is generically recognized in the British Museum collection, as is also *Bankivia*, but *Leiopyrga* is given subgeneric rank under the latter.

Calliostoma tigris (Martyn, 1784). [P. 148.]

Add as a synonym *Turbo granatum* Bolten, Mus. Bolten., p. 88, 1798. This name is given to Der Granat-Apfel (T. Martin, Univ. Conch., 2, fig. 75), so that the synonymy is exact.

Margarella decepta (Iredale, 1908). [P. 133.]

I will shortly give a figure of the shell I described as *Photinula decepta*, which has not yet been figured. It closely resembles *Photinula violacea* (Sowerby), and must be classed in the same genus. From examination of the radular characters the species of the *caerulescens* group (true *Photinula*) have been separated from the forms allied to *violacea*. Such a separation is amply confirmed by shell characters, so that *Photinula* can be dismissed from the Neozelanic fauna. I was the first to introduce it in connection with the species under discussion, and I did so on account of the apparent close relationship with *violacea*, which I only knew from literature. For the *violacea* group Thiele proposed (Gebiss d. Schnecken, vol. ii, p. 259, 1891) *Margaritella*, quoting *violacea*, *expansa*, and the New Zealand *antipoda*. The genus-name being preoccupied, he has since amended it to *Margarella*. This name should be used. Suter has rejected this name, using *Photinula*, making the remark, "Thiele included in his genus *Margarella* our species *P. nitida* and *P. antipoda* because the dentition shows a close resemblance. *Margarella* stands, no doubt, nearer to *Valvatella*, the animal having jaws." The conchological features of *antipoda*, *decepta*, and *violacea* are essentially identical, whilst *nitida* shows quite different features.

The first three must be grouped together, whilst the last must be separated; and though the shell described as *Photinula suteri* by Smith has been classed in *Gibbula* by Suter on account of the presence of jaws, it is much nearer *Margarella*, and I would there place it for the present. I believe, from a criticism of the shells—and this is confirmed by examination of the radula—that the recognition of the jaws depends too much upon the personal equation, and cannot in the present state of our knowledge be depended upon. I would therefore reject *Photinula*, and replace it by *Margarella*, and recognize three Neozelanic species, thus:—

Genus MARGARELLA Thiele. Synonym: *Margaritella* Thiele, 1891, not Meek and Heyden, 1860.

Margarella antipoda (Hombron and Jacquinot, 1854). Synonym: *Chrysostoma rosea* Hutton, 1873.

—— *decepta* (Iredale, 1908).

—— *suteri* (E. A. Smith, 1894).

I see no good purpose in retaining Hutton's name *rosea* for a variety, as the colour-variation is endless, and there is no definition.

Gibbula nitida Ad. & Ang., 1864, which Suter placed in *Photinula* because the animal had no jaws, is certainly not congeneric with the above, and shows a much closer relationship with *G. picturata* of the same authors, which Pilsbry made the type of *Cantharidella*, a section of *Gibbula*. Jaws are said to be present, but neither of these species has a very close relationship to *Gibbula*.

Genus **Solariella** Searles Wood. [P. 140.]

Under this genus-name in the British Museum is placed the shell known to Neozelanic collectors as *Monilea egena* Gould. It should be remembered that this generic (*Monilea*) location was simply Hutton's solution, as Pilsbry in his monograph states he did not know it, and therefore followed Hutton. To my eyes the Neozelanic shell was not congeneric with *Monilea*, but was nearer *Minolia*, which Suter used subgenerically for some other Neozelanic species. I could not see any subgeneric difference between these, and they seemed well placed in *Solariella*.

Mr. E. A. Smith has just told me that he cannot determine *Monilea* Swainson, that he cannot separate *Minolia* from *Solariella*, and that all the Neozelanic species are congeneric. His conclusions will be published before this is in print, but it is certain that *Monilea* must be rejected, and in its stead *Solariella* may be used, and all the Neozelanic species be so classed.

Fam. **Trochidae.** [P. 150.]

Add: Genus ANGARIA Bolten. *Angaria* Bolten, Mus. Bolten., p. 71, 1798. Type: *Turbo delphinus*, Linné. Synonym: *Delphinula* Lamarck, &c.

This genus has not yet been recorded from New Zealand, though I have recorded two species at the Kermadec Islands. From dredgings made at that place I sorted out many minute shells, and a long series enabled me to recognize the growth stages of this genus. They show no form or sculpture at all like the adult, and do not appear to have yet been figured. The two species, *Liotia serrata* Suter, 1908 (p. 151), and *Liotia solitaria* Suter, 1908 (p. 152), are probably both juveniles of this genus: the latter certainly is, whilst the species Suter compared it with—viz., *L. stellaris* Ad. & Rve.—is also a juvenile *Angaria*, as is shown here in the British Museum, the type being so placed when it was described.

The presence of the genus in north Neozelanic waters is not strange, as it occurs on all the three northern groups—Lord Howe Island, Norfolk Island, and the Kermadecs. From the two former it is as yet known only by juvenile and half-grown specimens dredged, but at the Kermadecs one species was rarely obtained, alive and adult, below low water. The juveniles dredged show great variation, so that I cannot refer Suter's two species to any named species, nor decide whether they are conspecific. The only conclusion under such circumstances is to admit both, and draw attention to the matter, so that adults may be looked for. Will northern collectors please note.

Genus ANGARIA Bolten, 1798.
Angaria serrata (Suter, 1908).
—— *solitaria* (Suter, 1908).

Fam. Liotiidae Iredale. [P. 150.]

I propose this family name for quite a different association to the family *Liotiidae* Gray, used by Pilsbry and Suter. That name is based upon the usage of *Liotia* for the shells with heavily varicosed aperture, and operculum with a calcareous superimposition in the form of spirally disposed particles. No member of this group inhabits New Zealand as far as is yet known, though I collected a typical species at the Kermadecs.

In the Proc. Mal. Soc. (Lond.), vol. ix, p. 257, 1911, I showed that *Liotia* Gray was proposed for the shells typified by *Delphinula cancellata* Gray, and that species did not possess a variced mouth nor a calcareous operculum. The name for these latter I also concluded was *Liotina* Fischer (Man. de Conch., p. 831, 1885), with type *L. gervillei* Defrance. I have since recognized that the type of *Liotia* agrees with *Cyclostrema micans* A. Adams in every essential particular. The types of both are before me. As this was selected by Tate as typical of a new genus *Pseudoliotia*, that name falls as an absolute synonym of *Liotia* Gray. The species classed by Suter under *Liotia* have no relationship with that genus.

On p. 152 the family *Cyclostrematidae* Fischer is admitted. This would partly represent my family *Liotiidae*.

On p. 153 the genus *Cyclostrema* is utilized for a species—*Cyclostrema eumorpha* Suter. Suter's arrangement is based upon that proposed by Miss Bush after a study of west North American forms. I have investigated the austral species in view of Miss Bush's conclusions, and cannot advise that the groups there proposed should be introduced into Neozelanic literature. Miss Bush, however, killed the ghost of *Cyclostrema*, as it appeared that no one previously had examined the matter, but simply used *Cyclostrema* as a "waste-paper basket" for puzzling minute Trochoids. I am sorry that this usage still persists, a chief offender being Melvill, who wrote upon the *Cyclostrematidae* of the Persian Gulf (Proc. Mal. Soc. (Lond.), vol. vii, pp. 20–28, 1906), and has since described species of "*Cyclostrema*" most obviously not congeneric with the type. The genus "*Cyclostrema*" was proposed for a shell found among some West Indian forms. The type is lost, and the nearest species known comes from the Philippines. I have often studied the figure and description of Marryat's genus and species, and these seem to represent an immature shell which might have developed into a species of what I call *Liotina*. I would suggest that the name be dismissed as indeterminable, especially as it has been so casually used in no scientific manner.

On p. 154 *Delphinoidea* is included, but the species so classed bears little resemblance to the British shell, which is the type of the genus.

On p. 157 Miss Bush's fam. *Vitrinellidae* is admitted, but the shells placed under this name bear little or no resemblance to *Vitrinella*, and the name should be dismissed at once from Neozelanic literature.

Miss Bush's *Lissospira* is also introduced for the minute turbinate species, *corulum* Hutton, 1885, and *micra* Tenison-Woods, 1877. The former of these has little resemblance to the species of *Lissospira*, and I have already proposed to seperate it generically. The latter bears only superficially the aspect of species of *Lissospira*. Moreover, Miss Bush recognized as a subgenus of *Lissospira* the genus *Ganesa* Jeffreys. That name has long priority, but the species are quite unlike the austral species.

Thiele has shown that most of the Antarctic shells, which closely resemble boreal species—so much so that previous workers had considered them congeneric—showed vast differences when the aninals were examined. In my own case, I cannot separate shells of *Heterorissoa* and *Jeffreysia*, yet the opercula notably differ, and Thiele has been able to recognize several genera in the southern so-called "*Jeffreysia*."

Under these circumstances, I unhesitatingly reject *Lissospira*, and also *Cyclostremella* Bush, admitted by Suter on p. 160. This latter genus was proposed for such a shell as the Australian *Cyclostrema charopa* Tate, but Thiele has differentiated an Antarctic genus under the name *Microdiscula*. The austral species I would class under this name rather than under Miss Bush's, especially as she writes, "Nuclear whorl relatively large, turned downward, seen only in a basal view, leaving a small pit above." No austral form I have examined shows this character. Suter's *Cyclostremella neozelanica* seems to show no affinity with either *Cyclostremella* Bush or *Microdiscula* Thiele, but differs in almost every particular, as will be hereafter shown.

Circulus Jeffreys is, on p. 159, introduced into the *Neozelanic* fauna to include a shell very closely allied to "*Cyclostreme*" *tatei* Angas. There is quite a large group of Indo-Pacific shells agreeing vaguely in character with *C. tatei* Angas, but these do not correlate with the type of *Circulus* when actual specimens are compared.

The whole of the Neozelanic and Australian species bear a different look when specimens (not descriptions and illustrations) are brought alongside European forms, and I advocate the rejection of European names until animals are examined.

I herewith introduce four new generic names for usage in connection with the Neozelanic forms, and most of these will come into use for Australian species. I have collated some sixty generic names proposed for shells of this group, and I have examined the types of the majority of these genera and most of the species, both fossil and Recent, allotted to the genera named, in the hope that I may at some time produce a monograph of the whole group. In addition to the named forms, I have many unnamed species from the Kermadec Islands, Lord Howe Island, and Norfolk Island, and these have been utilized in consideration of the groups here named. The usage of these would certainly obviate such incongruous assemblage as my friend Mr. Hedley (Proc. Linn. Soc. N.S.W., vol. xxxiv, 1909) has produced in classing figs. 40, 41, 42, 43, 44, 45 on plate xxxix as *Liotia*, and figs. 46, 47, 48, pl. xxxix, and figs. 49, 50, 51, pl. xl, as *Cyclostrema*.

Liotella gen. nov. [P. 151.]

I introduce this genus-name to cover a series of minute shells which have been classed by Australasian workers in *Liotia*, but which differ in their texture, do not possess a thickened peristome, and are more or less loosely coiled. I name as type *Liotia polypleura* Hedley, a species I am very familiar with, and that shell has a multispiral horny operculum with a central nucleus. The second species on p. 151 (*Liotia rotula* Suter) would be here classed, and I would suggest the addition of *Liotia annulata* Ten.-Woods (Proc. Roy. Soc. Tasm., 1877, p. 121, 1878); *Liotia anxia* Hedley (Proc. Linn. Soc. N.S.W., vol. xxxiv, p. 437, pl. 39, figs. 43 45, 1909); *Liotia petalifera* Hedley (Rec. Austr. Mus., vol. vii, p. 116, pl. 22, figs. 6 8, 1908); *Liotia disjuncta* Hedley (Mem. Austr. Mus., iv, p. 336, fig. 66 in text, 1903); and *Homalogyra pulcherrima* Brazier (Proc. Linn. Soc. N.S.W., vol. ix, p. 175, pl. 14, fig. 13, *a*, *b*, 1894). These are all obviously neither *Liotia* nor *Liotina*, and, though I suggest all are not congeneric, the present location is good as a temporary one, though not permanent.

Zalipais gen. nov.

Suter described a minute shell as *Cyclostrema lissum* in 1908, and he now disposes of it in *Delphinoidea* Brown. That genus is based upon a British shell which I do not consider congeneric with Suter's *C. lissum*, which was one of my first discoveries when investigating the minutiae found living in seaweeds in tide-pools at dead low water on the New Zealand coast. I sent Mr. Suter specimens for examination from Blind Bay, Nelson, in addition to the localities he mentions, and I also obtained it at Sandfly Bay, Otago Peninsula. It is probably well distributed, but we have knowledge of very little of the New Zealand minute marine molluscs as yet.

I propose the above generic name, naming *C. lissum* Suter as type, and anticipate many additions. I have another Neozelanic species, yet undescribed, before me, but at present I do not know any Australian species I would refer here.

Lissotesta gen. nov.

I mentioned to Mr. Suter in 1907, when I passed through Auckland on my way to the Kermadec Islands, that I had written to Mr. Hedley asking his opinion with regard to *Cirsonella ? neozelanica* Murdoch. I had compared the type of *Cirsonella*, and from shell characters it was not congeneric, and the anatomical details given by Murdoch confirmed this conclusion, whilst the operculum made the rejection of the species from *Cirsonella* certain. Mr. Hedley has replied suggesting *Assiminea*, and agreeing with my opinion. On p. 155 *Cirsonella neozelanica* is included, but on p. 1082 there is a note quoting Thiele's investigation and its tentative reference to *Acmella* in the subfamily *Omphalotropidinae* of the family *Pomatiasidae*, which is certainly a much better location.

The first species, *Cirsonella densilirata* Suter, 1908, is certainly correctly placed under the genus *Cirsonella* in the present state of our knowledge, but the third species, *Cirsonella granum* Murdoch and Suter, 1906, I would remove to my genus *Lissotesta*, which I here propose for the shells about *Cyclostrema micra* Ten.-Woods, 1877, which I name as type. Yet Suter has placed the former in the family *Cyclostrematidae*, and the latter in the family *Vitrinellidae*.

These "featureless" "Cyclostrematids" are difficult to place from figures and descriptions alone, but the two here mentioned are conchologic-

ally as alike as any of these things are. Thus I would here place *Cyclostrema torridum* Hedley (Proc. Linn. Soc. N.S.W., vol. xxxiv, p. 438, pl. 40, figs. 49–51, 1909); and I at one time considered *C. porcellanum* Tate and May would belong here, but examination of specimens in the British Museum, marked "co-types," shows this species to have an oval aperture quite repugnant to my genus, and recalling shells I collected in New Zealand and which from opercular characters were referred to *Laevilitorina*.

Elachorbis gen. nov.

On p. 153, under *Cyclostrema*, Suter has placed his own *Cyclostrema eumorpha*, and on p. 159, under *Circulus*, he has ranged his *Cyclostrema subtatei*.

There is a large group of minutiae similar in general characters to *Cyclostrema tatei* Angas, and I propose the above genus for these, with that species as type. There cannot be recourse to *Cyclostrema*, as already pointed out, and *Circulus*, from examination of the type, would be a bad substitute.

Melvill has described a whole series of species from the Persian Gulf under the genus-name "*Cyclostrema*" which would come into this genus. Melvill's idea of "*Cyclostrema*" as further exemplified in the Trans. Roy. Soc. Edinb., vol. xlviii, 1912, pp. 345–46, is about as vague as the Linnean *Helix*, as he admits "this genus is somewhat multifarious already in its component parts."

Leptothyra imperforata (Suter, 1908). [P. 156.]

This is where I should place the shell named *Pseudoliotia imperforata* by Suter. *Pseudoliotia* Tate, from examination of types, agrees exactly in every detail with *Liotia* Gray, and must be ranked as an absolute synonym of that name.

I have not seen Suter's species, but the description and figure agree very closely with the type of *Leptothyra*, and until the opercular characters are known this should be its generic location.

When Hedley introduced *Liotia latebrosa* (Proc. Linn. Soc. N.S.W., vol. xxxii, 1907, p. 493) he commented, "The shell resembles *Leptothyra*, but the operculum is of a different type. It seems to me probable that neither *Leptothyra* nor *Collonia* occurs in Australasian seas, and that the species which have been ascribed to them ought to be transferred to *Liotia*." This was written before I had shown that *Liotia* Gray was not *Liotia* Auct., and with our present knowledge it is quite impossible to class Hedley's *Liotia latebrosa* with either *Liotia* Gray (= *Pseudoliotia* Tate) or *Liotina* Fischer (= *Liotia* Auct.).

Hedley admitted (loc. cit., p. 479) *Leptothyra laeta* Montrouzor, and this fairly agrees with typical *Leptothyra*. The species I found at the Kermadecs and recorded as *Leptothyra picta* Pease is also quite a typical shell. The present species does not closely resemble *Cyclostrema micans* A. Adams, but recalls *Collonia roseopunctata* Ten.-Woods, and this would also range under *Leptothyra*.

The species Suter includes in *Leptothyra* (pp. 164–65) are not congeneric, and I will deal with these when I arrive at those pages.

Brookula corulum (Hutton, 1885). [P. 158.]

The shell described as *Scala corulum* by Hutton was temporarily placed under *Cyclostrema* by Suter and myself in 1908. Suter now ranks it under

Lissospira, which it disagrees with in almost every particular. I have introduced (Proc. Mal. Soc. (Lond.), vol. x, p. 219, 1912) the genus-name *Brookula*, with type the Kermadec species *B. stibarochila*, and the group thus named is quite a large one, and well defined.

Liotella ? neozelanica (Suter, 1908). [P. 160.]

Suter's *Cyclostremella neozelanica* is autoptically unknown to me, but it is obvious that it is not a *Cyclostremella*. I have seen species somewhat recalling Suter's figure and description, and until I know them better I would class them as close relations of *Liotella* spp.

My disposition of the species ranked by Suter in the families *Liotiidae*, *Vitrinellidae*, and *Cyclostrematidae* (pp. 150–61) are as follows :—

Transfer *Liotia serrata* Suter, 1908, and *Liotia solitaria* Suter, 1908, to the genus *Angaria* Bolten, 1798, in the family *Trochidae*. Transfer *Cirsonella neozelanica* Murdoch, 1899, to the genus *Acmella* in the family *Pomatiasidae*. Transfer *Pseudoliotia imperforata* Suter, 1908, to the genus *Leptothyra* in the family *Turbinidae*. The remainder may be classed in the family *Liotiidae* Iredale, as hereafter named :—

Fam. LIOTIIDAE Iredale.
Genus LIOTELLA nov.
Liotella polypleura (Hedley, 1904).
—— *rotula* (Suter, 1908).
—— *? neozelanica* (Suter, 1908).
Genus ELACHORBIS nov.
Elachorbis eumorpha (Suter, 1908).
—— *subtatei* (Suter, 1907).
Genus ZALIPAIS nov.
Zalipais lissa (Suter, 1908).
Genus CIRSONELLA Angas, 1877.
Cirsonella densilirata (Suter, 1908).
Genus BROOKULA Iredale, 1912.
Brookula corulum (Hutton, 1885).
Genus LISSOTESTA nov.
Lissotesta micra (Ten.-Woods, 1877).
—— *granum* (Murdoch and Suter, 1906).

There are many species and genera living in Neozelanic waters to reward the worker who will undertake search for these delightful minutiae. I have before me at this time more than half a dozen species representing genera new to the Neozelanic list and others referable to the above-named genera.

Subgenus Lunella (Bolten, 1798). [P. 162.]

"*Marmorostoma* Swainson, 1840; type, *T. porphyreticus* Mart.," is utilized by Suter in a subgeneric sense for *Turbo smaragdus* Martyn. This name is untenable in this connection, as it was first proposed by Swainson in the Zool. Illus., 2nd ser., vol. i, 1829, pl. 14, where he wrote, "From the genera *Turbo* and *Trochus* of modern conchologists we have detached all those species whose shells are closed by a calcarious [sic] operculum; and this group we propose to distinguish by the name of *Marmarostoma*." He then named as type "*Turbo chrysostomus* L."

In the "Treatise on Malacology" (1840, p. 215) Swainson amended this proposal thus: "Before we had sufficiently studied this family we

included the foregoing in our genus *Marmarostoma*, but we intend to limit that name to the umbilicated division of Humphrey's *Senectus*, represented by the *M. versicolor* (*Turbo versicolor* Martini, pl. 176, figs. 1740, 1741)." Such a transposition of names is not permissible, and the first usage of *Marmorostoma* prohibits its use in any connection, as it falls as an absolute synonym of *Turbo* s. str. In Trans. N.Z. Inst., vol. xxxviii, 1905, p. 324 (1906), Suter wrote, " The subgenus *Lunella* Bolten, 1798, used by Webster, should be replaced by *Marmorostoma* Swainson, 1840, as most conchologists reject the names proposed by Bolten." At the present time the converse is the case, as practically every systematist now recognizes the Boltenian genera. The chief antagonist (Mr. A. J. Jukes-Browne) of the Boltenian genera has recently passed away, and I at present know of no other opponent.

Lunella Bolten (Mus. Bolten., p. 103, 1798) can therefore be used instead of the doubly invalid *Marmorostoma* Swainson, 1840, which, if quoted in the synonymy, should be accompanied by the words " not of Swainson, 1829."

Turbo smaragdus (Martyn, 1784). [P. 162.]

To the synonyny of this species add (*Helix*) *Smaragdus minor* Martyn (Univ. Conch., vol. ii, pl. 74, 1784), *Turbo smaragdinus* Bolten (Mus. Bolten., p. 86, 1798).

I notice with pleasure that Suter has also included *Turbo smaragdus* var. *tricostatus* Hutton, 1884. My own collecting led me to endorse Suter's suggestion (Trans. N.Z. Inst., vol. xxxviii, 1905, p. 324, 1906) that " further investigation will show that all young shells of *T. helicinus* (= *smaragdus*) are tricostate." The plate given by Martyn, and named as above, shows two beautiful paintings of half-grown shells which clearly portray the tricostate stage, and if such had been separable Martyn's name, given just one hundred years before Hutton's choice, would have claimed usage.

Another synonym, which I will later discuss, seems to be *Omalogyra bicarinata* Suter (Proc. Mal. Soc. (Lond.), vol. viii, p. 33, 1908).

Argalista gen. nov. [P. 164.]

I propose this generic name for *Cyclostrema fluctuata* Hutton. This species, along with *Leptothyra crassicostata* Murdoch, belongs to a group confused with *Leptothyra* and *Collonia*. The true species of *Leptothyra* are very different shells, with different opercular characters. *Collonia* is a name that has been recently restricted to fossil shells somewhat recalling *Argalista*, but the name is so uncertain that it cannot be here recommended for usage.

I have before me new species of *Argalista*, and Hedley has described *Liotia latebrosa* in 1907 (see under *Leptothyra imperforata* Suter, *ante*) and more recently *Leptothyra fugitiva* (Zool. Res. Fish. Ex. " Endeavour," pt. i, p. 102, pl. 18, figs. 18–20, 1911), which probably, with *Teinostoma rotatum* Hedley (Mem. Austr. Mus., iii, p. 553, fig. 65 in text, 1899) and many other species, would fall into the present genus.

Astraea sulcata (Martyn, 1784). [P. 167.]

As a synonym, add *Cidaris novaezeelandiae* Bolten (Mus. Bolten., p. 85, 1798). This name is given to Der neuseeländische Turban (Chemn., 5, t. 164, fig. 1550). The figure is numbered 1551, and is easily recognizable.

Genus **Phasianella** (Lamarck, 1804). [P. 168.]

Many synonyms might here be added. The following refer only to the typical section, and are absolutely exact :—

Phasianus Montfort, Conch. Syst., vol. ii, pp. 254–55, 1810 (not *Phasianus* Linné, 1758).

Bolina Rafinesque, "Analyse Nature," p. 144, 1815. *Orthopnoea* Gistel, Naturg. Thierr. Schul., p. 169, 1848. Both these are simply substitute names for "*Phasianella* Lam."

Eutropia Humphrey was quoted by Swainson (Treat. Mal., p. 21, 1840) as being equal to *Phasianella* Lam., and was so used by Adams Bros.

Eutropia H. and A. Adams, Gen. Rec. Moll., vol. i, p. 389, 1854.

Genus **Umbonium** (Link, 1807). [P. 170.]

Umbonium Link, Beschr. Samml. Rostock., 1807. Type: *Trochus vestiarius* Linné.

As synonyms may be noted *Globulus* Schumacher, 1817, and *Rotella* Lamarck, 1822. A full synonymy will be given later.

This genus is not clearly defined from *Ethalia* A. Adams, which Suter has used, following Pilsbry, for the New Zealand shell "*Ethalia zelandica* H. & J." In the British Museum *Ethalia* is only given subgeneric rank, which looks natural to me; but whatever value is hereafter accorded *Ethalia* I conclude that the Neozelanic shell will be classed in *Umbonium*. It is so placed in the British Museum. *Ethalia* is much younger, in date, than *Umbonium*, but even if used subgenerically the Neozelanic shell would fall into *Umbonium* s. str. *Ethalia* must be altogether eliminated from Neozelanic usage.

Umbonium anguliferum (Philippi, 1853). [P. 170.]

Globulus anguliferus Philippi, given by Suter in the synonymy of "*Ethalia zelandica* Hombron and Jacquinot, 1854," was really published in 1853, and therefore has clear priority over the name assigned to Hombron and Jacquinot, but only published by Rousseau in 1854.

The reference to the genus *Ethalia* is due to Pilsbry's initiative when he monographed the group in the "Manual of Conchology." I cannot understand his argument, as he referred Crosse's *U. thomasi* to *Umbonium*, and these two species are very nearly allied, and certainly congeneric. I note he has since indicated that the traditional identification of Quoy and Gaimard's *guamensis*, the type of *Ethalia*, may be incorrect. However, A. Adams (Proc. Zool. Soc., 1853, 188 (1854)) proposed two new species of *Umbonium*—*U. zealandicum* and *U. chalconotum*. These are synonyms of the present species, and they are not congeneric with H. and A. Adams's *Ethalia guamensis*, which is now before me, whether this be Quoy and Gaimard's species or not. The first introduction of *Ethalia* is by H. and A. Adams, Gen. Rec. Moll., vol. i, p. 409, May 1854. The type is "*guamense* Quoy & Gaim."

Genus **Murdochia** (Ancey, 1901). [P. 177.]

I would like to see this name come into use for the Neozelanic shells at present classed in *Lagochilus*. All Neozelanic workers, as well as extralimital malacologists, deeply regret the withdrawal of Mr. R. Murdoch from the active study of the Neozelanic molluscan fauna.

My reasons for the recognition of *Murdochia* are that *Lagochilus* Blandford, 1864, is antedated by the prior names *Lagochilas* and *Lagochile*. These names are being considered near enough to invalidate Blanford's name by most present-day workers. *Cytora* Kobelt and Moellendorff, 1902 or 1897, is long predated by *Cytorus*, and is therefore unavailable.

Genus **Palaina** (Semper, 1865). [P. 185.]

The reference to *Palaina* is not given, and, as I had occasion to look it up, it may be here noted:—

Palaina Semper, Journ. de Conch, vol. xiii, p. 291, 1st July, 1865. Synonym: *Pupoidea* Pease, Amer. Journ. Conch., vol. i, p. 290, 1st October, 1865.

Suter notes that the occurrence of the species in New Zealand requires confirmation.

I have examined the type, and it closely approaches some forms from Lord Howe Island, but though I have tried to match it I have not yet succeeded. The Lord Howe land molluscan faunula is so certainly derived from that of New Caledonia that search in that island may reveal the habitat of the supposed Neozelanic shell. My criticism of the type leaves no doubt that it came from New Zealand, New Caledonia, or Lord Howe Island.

Genus **Melarhaphe** Menke. [P. 186.]

I have recorded my conclusion (Proc. Mal. Soc. (Lond.), vol. x, p. 223, 1912) that this genus-name should replace *Littorina* for usage for the Australian shells commonly so called. Suter has given the correct reference to this name, but the type I named as *M. neritoides* (Linné). The species-name (p. 188) *mauritiana* Lamarck, 1822, should be rejected, as the Mauritian shells are much larger and easily separable. The next name is *L. unifasciata* Gray, 1826, given to an Australian shell, and this may be used, but I think the Neozelanic shell may prove subspecifically separable. A long series I collected at Caloundra, Queensland, were fairly constant, and showed slight differences, but I will later discuss these differences in more detail than I can at present.

Fam. **Rissoidae** Gray. [P. 198.]

"Rissoids" have given trouble to all systematists, on account of their small size. Few malacologists have deigned to study them, and most conchologists have utilized the name for any minute shell which could not be conveniently elsewhere placed. Hence, to the serious systematist "*Rissoa*" is the most displeasing name on record. I drew up a scheme for the differentiation of Australian "Rissoids" some six years ago. Unfortunately, my MS. was lost while travelling, and it has taken much study to arrive at a satisfactory appreciation of the austral forms in conjunction with the European forms. These latter have been generically divided and subdivided until there are about two generic names provided for each species.

With such a multiplicity of names available it seemed only a matter of comparison to select those suitable for Neozelanic shells, and then correlate synonyms. The Norman collection of palaearctic molluscs is now preserved in the British Museum, and such a wealth of material can scarcely be understood by the Neozelanic student. Series of shells from varied localities showing all growth stages and variation, with paratypes from most European workers, are there exhibited. I made a careful study of this

collection as regards these shells, and was astonished at my results. I had first collated all the generic, subgeneric, and sectional names proposed, with the types given by their author or the next worker to select such. *Rissoa* has had three types, named by three workers, and, whichever of these be considered the genus-name, *Rissoa* must be eliminated from Neozelanic literature.

I now propose a scheme of nomination adapted to austral species, and would urge its acceptance by austral students. It may seem at first arbitrary and in some ways inconsistent, but I believe it to be based on sound principles. It is the result of consideration of European Rissoids, both Recent and fossil, in conjunction with Australian, Neozelanic, and Lord Howe, Norfolk Island, Kermadec, and Lifu species. I deliberately mention these islands as I have many species from these groups, and these have reinforced the opinions produced by the study of the Neozelanic species alone.

Suter has accepted the genus *Rissoa*, admitting six subgenera—*Rissoa* (s. str.), *Alvania*, *Onoba*, *Ceratia*, *Cingula*, and *Setia*. As distinct genera he includes *Amphithalamus* and *Anabathron*.

More space than would be here allotted is required to record all the vicissitudes of Rissoid classification as regards austral forms. Here it can be noted that Hedley (Zool. Results "Endeavour," pt. i, p. 105, 1911) has rejected *Rissoa*, with type *Turbo cimex* L., as available for many austral species, and has substituted *Amphithalamus*. I do not agree with his association of species under the latter name, and these I will hereafter discuss. The type of *Rissoa* named by Hedley is the type of *Alvania*, so that name must also be omitted from consideration in connection with these species. The shell Suter names as type of *Rissoa* appears to have the best claim, but that will be discussed fully elsewhere.

Onoba, I conclude, can be used for certain Neozelanic shells without recourse to animal characters. *Ceratia* would be also available, but it is preoccupied. *Cingula* has no representative in New Zealand, whilst *Setia* is also preoccupied.

My scheme necessitates the introduction of new generic names for austral groups, and I would at once protest against the action of some conchologists who, without making any study of the subject, throw all new names into synonymy. If these minutiae be carefully studied, I prophesy the proposal of many more genera rather than the rejection of the few I separate.

Firstly, there is an austral group oscillating about *Rissoa cheilostoma* Ten.-Woods. This group is well marked, and I have half a dozen distinct species under review at the present time: these all agree in general appearance, in the spirally sculptured protoconch and the heavily varicosed somewhat oval aperture, though varying from minute slender elongate forms to large stout tightly wound forms. These have been classed in *Alvania* and *Alvinia*, but examination of the type of *Alvania* shows a very different style of shell. *Alvinia* recalls them, but species of that genus have a smooth protoconch, and are different in texture, resembling that of *Brookula*. A number of small shells with a smooth protoconch and a *Brookula* appearance also occur in Australian waters, but these when compared with *Alvinia* do not match at all, showing the great difficulty of judging "Rissoids" from descriptions or figures. I will elaborate this group later, as I know no Neozelanic species, though *Rissoa pingue* Webster, a species I am not autoptically acquainted with, may belong here.

A series of species show a spiral sculpture only, the above-named being all clathrately sculptured. These differ in other details, but the association hereafter mentioned does not seem natural. *Rissoa suteri* Hedley is the only Neozelanic example. This is classed by Suter in *Onoba,* but neither it nor the other species so classed by Suter, *R. foliata* Suter, have much in common with the type of *Onoba*. This species, *striata* Montagu, I have collected in Devonshire, England, and it accurately agrees conchologically with the shells named by Webster *R. candidissima* and *R. carnosa*. The confusion present in Suter's arrangement can be gauged from the fact that the former is placed in the genus *Rissoa* under the subgenus *Alvania*, whilst the latter appears in the genus *Rissoina* under the subgenus *Moerchiella*. Yet both are typically *Onoba*, not like the species *Onoba glomerosa* Hedley, somewhat atypical. *Ceratia* is invalidated by the prior *Ceratias*.

Otherwise the shells so classed by Suter agree fairly well. The group is well represented, and might be regarded as a subgenus of *Onoba*, and would include most of the species placed by Hedley in *Onoba*.

Cingula is utilized for a series of species which may not be congeneric, but they certainly differ generically from the type of *Cingula*, a shell I collected numerously in Devonshire, England. Hedley has classed these in *Amphithalamus*, but his association of species differs from mine.

Setia cannot be resorted to for the "featureless" Rissoids, as it is preoccupied. It has been subdivided many times by European malacologists, and I will discuss the names hereafter.

Amphithalamus is a name I have a great dislike to, as it was given to a North American species, and the austral species so called have an austral name already available.

Anabathron was proposed for an Australian species, and the group is confined to austral seas, as hereafter observed.

Haurakia gen. nov.

This genus-name is provided for the species agreeing with *Rissoa hamiltoni*, which I name as type. I introduce this genus with some diffidence, as the species is conchologically quite close to *Turboella* Gray. The mouth of the type species of that genus disagrees, and it runs into quite a different form, named *Zippora,* which again varies, and has been generically named *Rissostomia*. The variations that more strongly recall the austral group have been named *Apicularia* and *Pusillina,* both by Monterosato, whilst *Sabanaea* was used by Monterosato for another, to me indistinguishable, group.

Apicularia and *Pusillina* agree very closely, as far as conchological characters go, with *Haurakia*, but as they appear rather obvious derivatives of *Turboella*, which differs very appreciably from the Neozelanic forms, I would reject both.

Merelina gen. nov.

I propose this name for the shells grouped around *Rissoa cheilostoma* Ten.-Woods, which I name as type.

The New Zealand specimens available differ at sight from Sydney shells so named, and I have found species of this genus to be fairly constant in their characters. The genus extends to Lifu as *Alvania pisinna* Melvill and Standen, which I collected commonly at the Kermadecs, and is undoubtedly congeneric.

I doubtfully locate here Webster's *R. pingue*, as the "glossy" protoconch indicates it as a member of another group; but it is almost impossible to generically place any Rissoid without study of actual specimens.

I would reject *Alvania* without much consideration, and *Alvinia* superficially recalls this group, but the texture differentiates this form easily. I would draw attention to a paper by Bartsch in the Proc. U.S. Nat. Mus., vol. xli, p. 333 *et seq.*, 1911, on the west American species of *Alvania.* No authority is given for the generic name, nor is there any synonymy collated, nor are comparisons given with any extra-limital forms even as regards generic affinity, yet species with smooth nuclear whorls, punctured (papillose) nuclear whorls, and spirally lirate nuclear whorls are lumped together, whilst the shells show spiral sculpture only or clathrate or both, with varicosed mouths or simple, oval or pear-shaped.

Alvania cosmia Bartsch, p. 352, pl. 31, fig. 4; *Alvania halia*, id., p. 354, pl. 31, fig. 5; and *Alvania aequisculpta* Keep, p. 358, pl. 32, fig. 7, seem to agree exactly from figures and descriptions with members of *Merelina* as here proposed, which, as far as Australasian waters are concerned, is a distinct well-marked group.

Subonoba gen. nov.

The species Suter classed under *Ceratia* are here so named, and I select *Rissoa fumata* as type. In addition to the three species included by Suter, other species are known to me from New Zealand. In general appearance these differ from *Onoba*, and they always entirely lack longitudinal ribs. The British species of *Onoba* sometimes show these very obscurely, but even then they are quickly recognizable.

Probably the shells classed by Hedley in *Onoba*—viz., *Onoba bassiana* (Zool. Res. Fish. Exp. "Endeavour," pt. i, p. 108, pl. xix, fig. 25, 1911) and *Onoba glomerosa* (Proc. Linn. Soc. N.S.W., vol. xxxii, p. 495, pl. xvii, fig. 23, 1907)—together with Watson's *Rissoa (Onoba) mercurialis* (Chall. Rep. Zool., vol. xv, p. 600, pl. xlv, fig. 12, 1886) could be here placed, as, though the two former do not fairly agree in general shape and mouth characters, they disagree much more with typical *Onoba.*

Lironoba gen. nov.

I designate as type of this new group *Rissoa suteri* Hedley. These heavily lirately sculptured forms seem to be unknown in European seas, as I have noted nothing that much recalled this species.

When Hedley (Proc. Linn. Soc. N.S.W., vol. xxxiii, p. 469, 1908) described *Rissoa imbrex* (pl. x, fig. 33) he wrote, "This species is related to a small group of spirally ribbed shells—*R. tenisoni* Tate, *R. layardi* Petterd, *R. agnewi* Ten.-Woods, and *R. unilirata* Ten.-Woods—among which it stands nearest to the last." Since then he has added *Rissoa lockyeri* (Zool. Res. Fish. Exp. "Endeavour," pt. i, p. 103, pl. xviii, fig. 22, 1911) and *Alvania praetornatilis* (Rec. Austr. Mus., vol. viii, p. 139, pl. xli, fig. 16, 1912), and this series may be temporarily classed, for the sake of convenience, together under the genus-name *Lironoba.* I write "temporarily," as some recall other genera, and further study may necessitate their transposition.

Rissoa wilsonensis Gatliff and Gabriel, Proc. Roy. Soc. Vict., vol. xxv, n.s., p. 68, pl. viii, fig. 4, 1913, also comes into this genus.

Estea gen. nov.

The shell described by Webster as *Rissoa zosterophila* is selected as type of this genus, which is as yet quite an austral evolution. When Melvill and Standen met with a species from Lifu they were quite puzzled, and referred it to *Barleeia*, a quite inadequate conclusion. Hedley (Zool. Res. Fish. Exp. "Endeavour," pt. i, pp. 105-8, 1911) has referred them to *Amphithalamus*, but that generic name should be restricted to the species grouped around *Rissoa scrobiculator* Watson and *R. jacksoni* Brazier (= *badia* Watson). These superficially agree with *Amphithalamus inclusus* Carpenter, but the operculum of that species seems undescribed. Hedley has figured an operculum in the mouth of his *Scrobs pyramidatus* (Mem. Austr. Mus., iv, p. 354, fig. 77 in text, 1903), and this seems to agree with specimens I have examined; but I hope to deal fully with the genus *Amphithalamus* at a later date. I have many species all clearly showing the "*Scrobs*" feature, which never seems to me to merge into such a mouth as that shown by the type of *Estea*.

The difficulty of classing these is shown by the fact that the genus *Nodulus* Monterosato resembles a distorted *Scrobs*-like species, whilst the genus *Pisinna* Monterosato suggests a combination of *Scrobs* and *Estea*, agreeing exactly with neither. Yet when Sacco discovered a fossil like *Scrobs* he named it *Parvisetia ? mioscrobsoides* (I. Moll. del Piemonte, pt. xviii, p. 32, 1895).

Then Bartsch (Proc. U.S. Nat. Mus., vol. 41, pp. 289-91, 1911) described west American species of *Nodulus*, after having dealt with the species of *Amphithalamus* (id., pp. 263-65), and thereto assigned shells whose figures recall such as were assigned by Tate and May to *Rissopsis* and Hedley to *Epigrus*. The species Tate and May put under *Nodulus* Hedley has referred to *Amphithalamus*.

When Hedley transferred *Rissoa bicolor* Petterd to *Amphithalamus* (Zool. Res. Fish. Exp. "Endeavour," pt. i, p. 106, 1911) he noted, "This seems synonymous with *R. annulata* Hutton (N.Z. Journ. Sci., ii, July, 1884, p. 173; Proc. Mal. Soc., iii, 1898, p. 3) from New Zealand, over which it has priority." I do not understand how this erroneous statement was made, as Webster showed that at the second reference a very distinct species was described, and that Hutton's *R. annulata* was only a form of Hutton's *R. olivacea*, the type of Hutton's genus *Dardania*. The second species he named *R. zosterophila* (Trans. N.Z. Inst., vol. xxxvii, 1904, p. 277, pl. ix, fig. 5 (1905)). and this is the type of my *Estea*. *Rissoa bicolor* Petterd I refer to the same genus, but specimens (practically paratypes) of this species in the British Museum agreeing with figures by Tate and May, as quoted by Hedley and more recently figured by Gatliff and Gabriel (Proc. Roy. Soc. Vict., vol. xxv, n.s., pl. viii, figs. 5, 6, 1913), are abundantly distinct from Webster's species.

I should consider that Hedley and May's *Rissoa columnaria* (Rec. Austr. Mus., vol. vii, p. 117, pl. xxii, fig. 9, 1908) showed every character of *Estea* clearly both in figure and description: "Aperture perpendicular, circular, peristome reflected all round."

Webster figured the operculum of *R. zosterophila*, and this disagrees with that of *Scrobs pyramidatus* Hedley aforementioned.

I suggest the inclusion under *Estea* of all the species Suter placed in the subgenus *Cingula*, with which they have very little in common.

I have more New Zealand species of *Estea*, and also species from Lord Howe and Norfolk Islands, where *Amphithalamus* also occurs, but I only procured examples of the latter genus from the Kermadec Islands.

Notosetia gen. nov.

This is provided for the "*Setia*" of Suter, and I name as type *Barleeia neozelanica* Suter. I consider it a heterogeneous assemblage, but consider it wiser to provide quite a new name than encumber Neozelanic literature with another unnecessary extra-limital innovation. I have studied the European "*Setia*," and could easily match some of the shells with Neozelanic forms, but as each European species has one or more generic names it would be difficult to fix a limit, and some of the Neozelanic forms differ widely. Further, the particular forms that conchologically agree are known, in the few cases that animal or opercular features have been studied, to disagree. The "Gordian solution" I therefore favour, and solicit criticism. In a like case Thiele referred such things to "*Rissoa*," and upon my remonstrance urged, "I know quite well they are not *Rissoa*, but I don't know what they are."

Nozeba gen. nov.

I recorded as Recent the species *Rissoa emarginata* Hutton, previously known only in the fossil state. I now provide for this species the above genus-name, and fix it as type. A second species is *Rissoina coulthardi* Webster. These two species are classed by Suter in *Rissoina* under the section *Zebina* H. and A. Adams.

The species of *Zebina* differ generically from those of *Rissoina*, whichever subgenus of the latter is compared. I collected a species of the true *Zebina* at the Kermadecs, and was at once struck by its peculiar Eulimoid aspect, and found later that some of the species had been described under the genus-name *Eulima*.

A recent consideration of the varied forms classed under *Rissoina* showed no other species easily compared with the two above named.

Dardanula gen. nov.

I propose this name to replace *Dardania* Hutton, 1882, which is preoccupied by *Dardania* Stål. Suter has dismissed this as a synonym of *Eatoniella* Dall, which he has ranked as a subgenus of *Rissoina*. The reference to *Rissoina* simply because the operculum shows an internal claviform nucleus is a degradation of conchological characters, as the association of shells by means of operculum alone would lead to chaos. If the operculum of *Dardanula* be compared with that of *Rissoina* it will be seen to differ widely, whilst from shell characters the two would never be ranged together. Thiele has shown that the genus *Eatoniella* has been utilized to cover diverse elements, examination of the animal showing different generic types to be thereunder confused. The operculum of *Dardanula* differs at sight from that of *Eatoniella*, so that generic distinction must be allowed.

Anabathron foliatum (Suter, 1908). [P. 204.]

When this species was described by Suter he placed it in the genus *Rissoa*, while he referred another shell to *Anabathron*, describing it as *A. gradatum*. I cannot exactly place the latter species, but it is certainly not referable to *Anabathron*, whilst the former just as decidedly is.

The genus *Anabathron* is well defined, and seems to be as yet only known from east Australian and Neozelanic waters. The species comprising the genus at present are: *Anabathron contabulatum* Frauenfeld, New South

Wales; *A. contortum* Hedley, 1907, Queensland; *A. ascensum* Hedley, 1907, Queensland; *A. foliatum* (Suter, 1908), New Zealand; *A. pagodiformis* Sowerby, 1914, New Caledonia. I have a sixth species, from Lord Howe Island, at present undescribed.

Estea roseola nom. nov. [P. 209.]

This is proposed for the *Rissoa rosea* Hutton, 1873, which is invalidated by *Rissoa rosea* Deshayes, Île Réunion Moll., p. 61, pl. vii, fig. 29, 1862. The reference to the genus *Estea* is tentative, as the specimens before me, identified from their coloration as Hutton's species, incline rather to *Amphithalamus*, and might be better grouped there. I suggest that more than one species is classed under *Rissoa rosea* Hutton through the prejudice of the coloration.

Notosetia subflavescens nom. nov. [P. 212.]

Suter's selection of *Rissoa atomus* in 1908 was invalid, as Smith had previously proposed the same name (Proc. Zool. Soc. (Lond.)) for a St. Helena shell. I rename Suter's species as above, but the generic location must be considered a tentative one.

Rissoina chathamensis (Hutton, 1873). [P. 220.]

This name must be used for the species commonly known as *R. rugulosa* (Hutton, 1873). Both names were introduced in the same place, but the one I select has five pages precedence, and therefore demands recognition. Suter suggests that it is scarcely distinct from some Australian species, but says that he has not the series available to settle the question.

Suter has admitted *Rissoina hanleyi* Schwartz, 1860, and, though he writes the specimens are "*undoubtedly*" this species, the determination may be queried. No other extra-limital species of *Rissoina* is recorded from New Zealand, and the Philippines are a long way off. *R. hanleyi* does not appear (at present) to be a common shell in intermediate localities.

My arrangement of the New Zealand *Rissoidae* would then be expressed thus:—

Genus HAURAKIA nov.
Haurakia hamiltoni (Suter, 1898).
—— *huttoni* (Suter, 1898).
—— *exserta* (Suter, 1908).

Genus MERELINA nov.
Merelina cheilostoma Ten.-Woods, 1877. Synonyms: *Rissoa plicata* Hutton, 1873, not Deshayes, 1838; *R. cheilostoma* var. *lyalliana* Suter, 1898.
—— (?) *pingue* Webster, 1906.

Genus ONOBA H. and A. Adams, 1852. *Onoba* H. and A. Adams, Ann. Mag. Nat. Hist., 2nd ser., vol. x, p. 358, Nov. 1, 1852. Type: *O. striata* (Montagu).
Onoba candidissima Webster, 1905.
—— *carnosa* Webster, 1905.

Genus SUBONOBA nov.
Subonoba foveauxiana (Suter, 1898).
—— *fumata* (Suter, 1898).
—— *insculpta* (Murdoch, 1905).

Genus LIRONOBA nov.
Lironoba suteri (Hedley, 1904).
Genus ANABATHRON Frauenfeld, 1867.
Anabathron foliatum (Suter, 1908).
Genus ESTEA nov.
Estea incidata (Frauenfeld, 1867).
—— *lampra* (Suter, 1908).
—— *roseola* nov.
—— *roseocincta* (Suter, 1908).
—— *subfusca* (Hutton, 1873).
—— —— var. *micronema* (Suter, 1898).
—— *zosterophila* (Webster, 1905).
—— —— var. *minor* (Suter, 1898).
—— *impressa* (Hutton, 1885).
—— *rufoapicata* (Suter, 1908).
Genus NOTOSETIA nov.
Notosetia subflavescens nov. Synonym: *Rissoa atomus* Suter, 1908, not Smith.
—— *infecta* (Suter, 1908).
—— *leptalea* (Murdoch, 1905).
—— *lubrica* (Suter, 1898).
—— *micans* (Webster, 1905).
—— *microstriata* (Murdoch, 1905).
—— *neozelanica* (Suter, 1898).
—— *porcellana* (Suter, 1908).
—— *stewartiana* (Suter, 1908).
—— *verecunda* (Suter, 1908).
—— *vulgaris* (Webster, 1905).
—— *? gradatum* (Suter, 1908).
Genus AMPHITHALAMUS Carpenter, 1865.
Amphithalamus hedleyi (Suter, 1908).
Genus RISSOINA D'Orbigny, 1840.
Rissoina hanleyi Schwartz, 1860.
—— *rufolactea* Suter, 1908.
—— *chathamensis* (Hutton, 1873). Synonym: *Rissoa rugulosa* Hutton, 1873.
—— *zonata* Suter, 1909.
Genus NOZEBA nov.
Nozeba coulthardi (Webster, 1908).
—— *emarginata* (Hutton, 1885).
Genus DARDANULA nov. Synonym: *Dardania* Hutton, Trans. N.Z. Inst., vol. xiv, p. 147 (1882), (not *Dardania* Stål).
Dardanula chiltoni (Suter, 1909).
—— *cuvieriana* (Suter, 1908).
—— *fuscozona* (Suter, 1908).
—— *limbata* (Hutton, 1883).
—— *olivacea* (Hutton, 1882).
—— —— var. *annulata* (Hutton, 1884).
—— —— var. *lutea* (Suter, 1908).

Probably we do not know even a quarter of the number of species of the family *Rissoidae* existing in Neozelanic waters. Many of the species seem to be local on the littoral, and very little dredging has yet been done. A day's seaweed-washing at almost any point would give a new species, whilst

shell-sand would easily add others at the same place, such inhabiting the sublittoral zone. It is, however, more than probable that when the animals are examined many will be found to belong to other families, and it is imperative that the present association be only recognized as a temporary one.

Omalogyra bicarinata (Suter, 1908). [P. 229.]

I have before me specimens which agree in detail with Suter's description and figure. They cannot be referred to *Omalogyra*, as the "peristome continuous" is quite antagonistic to that genus. I have many times studied them, and they do not carry adult features in my eyes. My series does not exactly prove, but I myself am of the opinion, that they represent the first stage in the growth of *Turbo smaragdus* (Martyn, 1784). The careful search for young microscopic forms at any locality would well repay the student, and such a puzzle as the present one would be quickly solved. The shells can be compared with the juveniles of *Angaria*, which Suter described as species of *Liotia* (*ante*). I have examined, as well as the European and Neozelanic species of *Omalogyra*, species from Sydney, New South Wales, Lord Howe Island, and Norfolk Island, and they are all easily recognizable.

Genus **Cerithiella** (Verrill, 1882). [P. 249.]

In the Proc. Mal. Soc. (Lond.), vol. ix, p. 260, 1911, I discussed the rejection of this name by Cossmann, and the proposition of the new name *Newtoniella*. According to the nomenclatural laws now in force, *Cerithiella* is the valid name for this genus, and must be used. Thiele, apparently independently, has also investigated the matter, and has endorsed my conclusion. Morris and Lycett introduced *Ceritella*, and this name does not clash with *Cerithiella*, which was proposed by Verrill in the Trans. Conn. Acad., vol. v, p. 522, 1882. Mr. Edgar A. Smith, I.S.O., recently working upon Antarctic shells, has considered the matter, and also confirmed my results.

The only Neozelanic species seems referable to the genus as defined by Harris and quoted by Suter, but disagrees somewhat with the type.

Seila terebelloides (Hutton, 1873). [P. 253.]

Suter used *Cerithium terebelloides* Martens, Crit. List, 1873, p. 26, as the basis of his *Seila terebelloides*, rejecting *Cerithium cinctum* Hutton of even date, writing, "Hutton's name has priority by one month, but the description is quite inadequate, and he himself adopted the name bestowed on the species by von Martens." Hutton, however, published Martens' name at the same time as his own—viz., in the Cat. Mar. Moll. N.Z., p. 107, 1873—so that Hutton's *C. cinctum*, p. 27, has only page, not time, priority. This is quite sufficient to legalize Hutton's name; but we are relieved from making any alteration, as Hutton's name-selection was anticipated by Bruguière (Tabl. Ency. Meth. Vers., pt. 2, p. 493, 1792).

The original reference, however, must be quoted: *Cerithium (Bittium) terebelloides* Hutton, Cat. Mar. Moll. N.Z., p. 107, 1873.

Calyptraea tenuis (Gray, 1867). [P. 284.]

Mr. E. A. Smith has shown that *Calyptraea scutum* Lesson is indeterminable, and that the correct name for the Neozelanic shell is *C. tenuis* Gray, Proc. Linn. Soc., 1867, p. 735.

Calyptraea novaezelandiae (Lesson, 1830). [P. 285.]

Suter has rejected this name in favour of the later one given by Quoy and Gaimard because the latter figured their species. This is not a valid reason, and, as Lesson's description is recognizable, his prior name must be conserved, as Suter himself had concluded only a very few years before (Trans. N.Z. Inst., vol. xxxviii, p. 326).

Crepidula costata Sowerby, 1824. [P. 287.]

When rejecting *C. aculeata* (Gmelin), Suter remarked, "Sowerby's species was first figured (1824), and his specific name has to be adopted." This statement is due to ignorance of the facts, as when Gmelin named his species he quoted no fewer than five figures in support as having appeared prior to 1791. However, Sowerby's name should be retained, as *Patella aculeata* Gmelin has been shown by Mr. E. A. Smith to be a different species.

Polinices vitreus (Hutton, 1873). [P. 290.]

If the identity of Hutton's *Natica vitrea* and Watson's *N. amphiala* be admitted, Hutton's name must be used. It is apparently rejected on account of the lack of figure, which is no valid reason. Watson himself repudiated the identity until shells were compared, and I do not know whether this has yet been done.

Trichotropis inornata (Hutton, 1873). [P. 296.]

Suter has rejected this name in favour of Sowerby's later *T. clathrata*, as this was figured and Hutton's species was not. Hutton's species has always been recognized, and Suter's alteration seems here to create quite unnecessary confusion, as hitherto no question of the availability of Hutton's name had arisen to the New Zealand student. Suter has given as habitat, "Throughout New Zealand, in deep water." I have found this species living also between tide-marks on Otago Peninsula.

I would agree with Suter that this species seems much nearer *Trichotropis* than *Lippistes*, and all the Australian forms are really better placed in the latter than the former genus.

Fam. **Cymatiidae** Iredale. [P. 302.]

I have recently advocated the recognition of this family-name, as Dall's name *Septidae* I proved to be invalid. The reasons for the alteration can be here summarized: Dall and Simpson (Bull. U.S. Fish. Commission, vol. xx, pt. i, p. 416, 1900) brought into use for the shells congeneric with *Murex tritonis* Linné the name *Septa* of Perry, 1811. This was done as *Tritonium*, commonly in use, was invalid. Dall then contributed an invaluable account, entitled "An Historical and Systematic Review of the Frog Shells and Tritons" (Smithson Miscell. Coll., vol. xlvii, pp. 114 *et seq.*, 1904). As this is not generally available to the Neozelanic student, I give a synopsis, so that my remarks can be followed :—

Fam. SEPTIDAE Dall.
Genus *Trachytriton* Meek.
Personella Conrad.
Ranellina Conrad.
Austrotriton Cossmann, 1903.

Fam. SEPTIDAE—*continued.*

Genus *Gyrineum* Link, 1807.

Eugyrina Dall, nov.

Argobuccinum Mörch, 1852.

Subgenus *Paralagena* Dall, nov.

Fusitriton Cossmann, 1903.

Priene H. and A. Adams, 1858.

Distortrix Link, 1807.

Cymatium Bolten, 1798.

Subgenus *Cymatium* s. str.

Sect. *Cymatium* s. str.

Lampusia Schumacher, 1817.

Ranularia Schumacher, 1817.

Tritonocauda Dall, nov.

Gutturnium Mörch, 1852.

Turritriton Dall, nov.

Tritoniscus Dall, nov.

Cabestana Bolten, 1798.

Subgenus *Monoplex* Perry, 1811.

Linatella Gray, 1853.

Genus *Septa* Perry, 1811.

This was certainly an advance on Cossmann's treatment of the previous year in the Essai Paléoconch. comp., vol. v, which was marred throughout by a disregard of the nomenclatural laws commonly observed. Kesteven had also attempted to show that all the species constituted a single genus (Proc. Linn. Soc. N.S.W., vol. 27, pp. 443–83, 1902); but his effort was prejudiced by lack of material, and consequent inability to fix relationships from figures alone. I have already indicated that this group calls for a competent monographer, as Dall's review was of a skeletal nature, and it is difficult to reconcile the shells with the preceding synopsis. Cossmann (Essai Paléoconch. comp., vol. vii, p. 232 *et seq.*, 1906) criticized Dall's classification, but his nomenclature does not agree with the facts, and his rejection of the Boltenian and Linkian genera obviates much discussion of his results.

As type of *Septa* Perry, 1811, Dall selected *Septa rubicunda* Perry = *nodiferum* Lamarck, 1822, and this was accepted, as there was no legal objection possible to Dall's action. Mathews and I have, however, showed that Perry, in an earlier work, named "Arcana" ("Victorian Naturalist," vol. xxix, 1912, pp. 9–11), had introduced the genus-name *Septa* in connection with the species *S. scarlatina* Perry = *Murex rubecula* Linné, 1758, alone. This species is not congeneric with *Septa rubicunda*, so that Dall's usage is invalidated. We observed that Pilsbry had cited *Septa* Perry, 1811, as a synonym of *Aquillus* Montfort, 1810; but as we now knew *Septa* to have been published on the 1st January, 1810, it should antedate Montfort's name, but that we did not know the date of publication of Montfort's work. I have since discovered that this was reviewed in the Gotting. Anzieger, as follows: Vol. i, pt. 2, p. 961, 19th June, 1809; vol. ii, pt. 2, p. 847, 28th May, 1810. The latter date is the one concerned; but *Aquillus* Montfort, 1810, is an absolute synonyn of *Cabestana* Bolten, 1798. For the *Tritonis* group, as *Septa* was unavailable, Dr. Dall ("Nautilus," vol. xxvi, pp. 58–59, Sept., 1912) suggested the use of *Nyctilochus* Gistel, 1848. However, upon looking into the matter I noted that this name was not applicable,

whilst another one proposed by Gistel—viz., *Charonia*—was. I therefore advocated the use of this genus-name (" Nautilus," vol. xxvii, p. 55, 1913), and also proposed that the family-name should be *Cymatiidae*, basing this upon the oldest generic name in the group, *Cymatium* Bolten, 1798.

From a criticism of the British Museum material I cannot advocate the recognition of all of Dall's groups, whilst the nomenclature must be amended.

Kesteven had suggested the abolition of all sectional grouping, and the reference of all the species to the genus-name *Lotorium* (= *Cymatium*), indicating that no marked groups were distinguishable. I do not agree with this statement, as there are certainly well-differentiated series, and Kesteven's connecting-links, in many cases, were due to a misunderstanding of the species so considered. I think that a mean between Dall's treatment and that of Kesteven would be an advancement; but much study must be given, as there can be no question that the group, from a taxonomic point of view, is a difficult one. Nevertheless, the association of such shells as *Murex labiosus* Wood and *Murex tritonis* Linné in the same genus seems inadequately to represent their relationship.

For the Neozelanic species I would consider the facts best shown by the scheme hereafter given. The British Museum collection has been arranged on Dall's plan, and I have simply amended it where it seems possible; but, as already stated, a competent monographer might alter my grouping, though I consider it shows the facts fairly well.

At the Kermadecs I obtained specimens of many species of this family and the family *Bursidae* which do not occur in Neozelanic waters as far as is yet known. The recent recognition of " *Cymatium parkinsonianum* Perry " suggests that some of these may yet be discovered in the extreme north of New Zealand.

My arrangement would read as follows:—

Fam. CYMATIIDAE Iredale.
  Genus *Charonia* Gistel, 1848.
    Charonia lampas (Linné, 1758).
    —— *tritonis* (Linné, 1758).
  Genus *Cymatium* Bolten, 1798.
    Subgenus *Monoplex* Perry, 1811.
      Cymatium parthenopeum (von Salis, 1793).
    Subgenus *Cabestana* Bolten, 1798.
      Cymatium exaratum (Reeve).
      —— *spengleri* (Perry, 1811).
  Genus *Austrotriton* Cossmann, 1903.
    Austrotriton parkinsonia (Perry, 1811).
  Genus *Argobuccinum* Mörch, 1852.
    Argobuccinum tumidum Dunker.
    —— *australasia* (Perry, 1811).

Charonia lampas (Linné, 1758). [P. 303.]

Mr. E. A. Smith, I.S.O., has recently investigated the status of *Murex lampas* Linné, Syst. Nat., ed. x, p. 748, 1758, from the Mediterranean Sea, and has shown (Journ. Conch., 1914) that it refers to the species *Triton nodifer* Lamarck, 1822. This name Suter has synonymized with *Septa rubicunda* Perry, 1811, which name, on the score of priority, is used. But Mr. Smith has also noted that *Tritonium opis* Bolten, Mus.

Bolten., 1798, p. 125, is the Mediterranean shell, and is also earlier than Perry's name. I cannot differentiate Australian, Kermadec, and Neozelanic specimens from Mediterranean examples, though I have been prejudiced in favour of that course by Hedley's decision (Biol. Res. "Endeavour," vol. ii, 1914, p. 65). In coloration, degree of nodosity, and size, austral specimens easily match northern shells, and I conclude variation is due to station of life, not locality. At the Kermadecs I found many examples living below low-tide mark which were all decollate, much eroded, and comparatively small; but specimens washed up from deeper water—probably 10 to 15 fathoms—were of much larger size, and quite clean. No difference whatever can be seen by me at present between these and northern shells. This would agree with Hedley's experience (loc. cit.), as I would regard his var. *euclia* (pp. 65–66) as a deep-water representative of the austral shell. The wrinkling on the columella and inner lip is a character which differs with age, younger specimens showing heavy wrinkling such as is seen in *tritonis* Linné, but this becomes obscured by a heavy callus with age. For Neozelanic and Australian shells I must therefore recommend the usage of *Charonia lampas* (Linné, 1758), and this conclusion necessitates the acceptance of *T. sauliae* Reeve as a synonym.

Cymatium parthenopeum (von Salis, 1793). [P. 305.]

Such is the name to be used for *Septa costata* (Born, 1778) given by Suter. *Murex costatus* Born, 1778, is preoccupied by *Murex costatus* Pennant, Brit. Zool., ed. 4, vol. iv, p. 108, 1777. The next recorded synonym is *Murex parthenopeus* von Salis, Reise Neapel., p. 370, 1793. According to Watson (Chall. Rep. Zool. vol. xv, p. 391, 1886), the reversion to this specific name should be welcomed. Suter has placed the species in the genus *Septa* under the subgenus *Lampusia* Schumacher, 1817. This is obviously an error. It must be classed in the genus *Cymatium* Bolten, 1798, and the subgeneric name is *Monoplex* Perry, "Conchology," pl. iii, 1811, this species being figured as fig. 3 under the name *Monoplex australasiae*, which was long ago selected as type of *Monoplex*. The name *Monoplex australasiae* should be added to the synonymy of the species.

Austrotriton parkinsonia (Perry, 1811). [P. 307.]

Austrotriton Cossmann, Essai Paléconch. comp., vol. v, p. 98, 1903, was proposed, with type the fossil *T. radialis* Tate, the species *abbotti* Ten.-Woods and *cyphus* Tate being noted as congeneric. When Kesteven wrote up his study of the genus *Lotorum* (= Fam. *Cymatiidae* mihi) (Proc. Linn. Soc. N.S.W., 1902), he said (p. 484), "*L. parkinsonianum* is the recent representative of *L. radiale, abbotti*, &c. This group is more distinct than any I have studied." Ten years afterwards (ib., vol. xxxvii, 1912) he figured *abbotti* and *parkinsonianum*, as well as *torterostris* Tate, to show the close relationship.

The Recent species *parkinsonia* Perry stands quite alone when compared with other Recent species, so that I make use of the generic fossil name, basing its use upon Kesteven's studies.

Triton strangei (A. Adams and Angas, 1864). [P. 308.]

The reference "*T. strangei* Ad. & Ang., P.L.S., 1878, pl. 15, f. 16," must be eliminated from the synonymy of *C. spengleri*. Pritchard and Gatliff

seem to be the authors of this mistake, as the two species are very distinct, and at the place given Smith figured Adams and Angas's type which was described in the same journal twelve years previously (p. 35) from Moreton Bay, Queensland.

As a matter of fact, from examination of types, I confirmed (Proc. Mal. Soc. (Lond.), vol. ix, p. 73, 1910) Tryon's reference of Adams and Angas's species to *Murex labiosus* Wood, Index Test. Suppl., 1828, p. 15, pl. v, fig. 18. I collected specimens at the Kermadecs agreeing accurately with both the types named. As far as I know, the species has not yet been found in Neozelanic waters, but it probably lives there, and may have been overlooked as the juvenile of some other species.

Triton waterhousei (A. Adams and Angas, 1864). [P. 308.]

This name is also given by Suter as a synonym of *Cymatium spengleri*. I collected specimens at the Kermadec Islands which I immediately differentiated from typical *C. spengleri*, and these were named *C. waterhousei* A. Ad. & Ang. for me by Mr. Hedley at Sydney. Mr. C. J. Gabriel, of Melbourne, Victoria, showed me specimens which he contended were gradations between *C. waterhousei* and *C. spengleri*. As my own series was small, for this reason I did not record *C. waterhousei* from the Kermadec Islands.

I have since received further specimens, and criticism of these in conjunction with the type force the conclusion that this species is quite distinct from *C. spengleri*. Kesteven (Proc. Linn. Soc. N.S.W., 1902, p. 475) also concluded that the two species were distinct, and gave what seem very good differential characters. I do not think *waterhousei* has yet been observed in Neozelanic waters.

Argobuccinum tumidum (Dunker, 1862). [P. 309.]

Ranella tumida Dunker, Proc. Zool. Soc. (Lond.), 1862, p. 239, Suter has included in the synonymy of *Argobuccinum argus* Gmelin, of which he gives as the range "Tasmania, Australia . . . Cape Colony . . . Chile." The most casual examination of Cape Colony shells, which probably Suter has not examined, convinced me of their distinction, the Cape being the type locality of *argus* Gmelin. Hedley (Proc. Linn. Soc. N.S.W., vol. xxxviii, p. 297, 1913), after examining the British Museum collection, advocated the recognition of the Australia-Neozelanic form as a distinct species, a course I emphatically endorse. The name given above is Hedley's selection.

Argobuccinum australasia Perry is also represented in South Africa by a distinct species, which I have asked Mr. E. A. Smith, I.S.O., who is much interested in South African shells, to describe. It differs at sight in the coloration of the outer lip, the "*leucostoma*" having dark red-brown teeth.

Philippia (Gray, 1847). [P. 316.]

As a subgenus of *Architectonica* Bolten, 1798, this name appears with the reference "*Philippia* Gray in Philippi Enum. Moll. Siciliae, i, 174; P.Z.S., 1847, 146. Type: *Solarium luteum* Lam." Here again I cannot guess who is responsible for such a confusion of facts.

In the Proc. Zool Soc. (Lond.), 1847, p. 146, Gray has written, "*Philippia* Gray, 1840 (Phil. Sicil., i, 174). *Solarium luteum* Lamk." Reference to Philippi's work shows that vol. i was published in 1836, not

1840 as quoted in Suter's work, and that at the page given (174) Philippi simply described *Solarium luteum* Lamarck. He there gave observations on the animal, stating it was apparently normally Trochine, and had a Trochoid operculum. I have already recorded that *Philippia* does not appear in any of Gray's writings, as far as I could trace, until 1847 (Proc. Mal. Soc., vol. x, p. 309, 1913).

Genus Omalaxis (Deshayes, 1830). [P. 318.]

Suter's matter in connection with this genus-name is copied from Dall. As long ago as March, 1911, I had, however, published the results of an investigation into the status of this name, and it shows how slow the publication of the work must have been when no consideration of that article was able to be incorporated by Suter. I there showed that the type of *Omalaxis* was not *Solarium bifrons* Lam., as quoted by Suter, but *Solarium disjunctum* Lamarck, conchologically a different shell. I stated that study of growth-stages of shells collected at the Kermadecs had shown such a shell as that described by Murdoch and Suter as *Omalaxis amoena* to become adult as *Heliacus*, and that this species should be there transferred. I have since received many more examples, and hope to give figures later. The genus-name *Omalaxis* must be eliminated.

Fam. Pyramidellidae Gray. [P. 327.]

Though not mentioned, it seems obvious that Suter's classification of this family is based upon Dall and Bartsch's monograph.

In the "Nautilus," vol. xxiv, pp. 52–58, 1910, I made some comments on the nomenclatural defects apparent in this monograph, indicating the grave danger of the inaccuracies being continually copied by workers who were unable, through want of literature, to check their references. I stated that I was at that time unable to criticize the arrangement and grouping of the species and genera. I have not yet completed my studies, but cannot recommend the acceptance of Dall and Bartsch's groups. Suter appears to have done so, and Hedley did at one time, but only for a very short time.

Genus Eulimella (Jeffreys, 1847). [P. 329.]

In my paper quoted I showed that the reference given by Dall and Bartsch, and copied by Suter, was wrong, and that the earliest introduction of the genus-name *Eulimella* was by Jeffreys in the Ann. Mag. Nat. Hist.

I cannot recognize *Eulimella* as a subgenus of *Pyramidella*, the formation of the mouth being a clear separative feature, whilst geographically the group has a wider range than *Pyramidella*.

Genus Syrnola (A. Adams, 1862). [P. 330.]

This group also deserves generic recognition, as it is well marked and easily defined. Moreover, it is a large group with a great range, and, if only for convenience' sake, would claim usage.

Genus Odostomia (Fleming, 1813). [P. 333.]

Suter has here accepted the incongruous association considered a genus by Dall and Bartsch. This method of accepting a huge unwieldly group with a multitude of sections, many of which seem unnecessary, does not

appeal to me. A large number of well-defined groups, considered as genera, makes a much more workable system, and that is all that can be asked for at present in connection with these minutiae. As far as I have gone, I have found little difficulty in recognizing at sight species of *Oscilla*, *Pyrgulina*, *Miralda*, and *Odostomella*, simply to cite the first names called to mind. Such an ultra-conservative worker as Melvill (Proc. Mal. Soc. (Lond.), vol. ix, p. 171, 1910) rebelled at Dall and Bartsch's retrogressive action, and I would consider the arrangement given by Melvill a better and more natural one than Dall and Bartsch's.

On p. 197 Melvill notes that Dall and Bartsch failed to distinguish between *Turbonilla* and *Odostomia* (sensu lato), a fact I had independently observed. Again, on p. 194 Melvill points out that *Cingulina* and *Oscilla*, which Dall and Bartsch confused, were easily separable, another item I independently recorded.

I have not yet carefully criticized all the Neozelanic forms, but would advocate the acceptance of the subgenera quoted by Suter as of generic value.

For this family the names would then read,—

Genus Eulimella Jeffreys, 1847.
Eulimella coena Webster, 1905.
—— *levilirata* Murdoch and Suter, 1906.
—— *limbata* (Suter, 1908).

Genus Syrnola A. Adams, 1862.
Syrnola lurida (Suter, 1908).
—— *pulchra* Brazier, 1877.
—— *tenuiplicata* (Murdoch and Suter, 1906).

Genus Turbonilla Risso, 1826.
Turbonilla zealandica (Hutton, 1873).

Genus Odostomia Fleming, 1813.
Odostomia acutangula Suter, 1908.
—— *bembix* Suter, 1908.
—— *cryptodon* Suter, 1908.
—— *denselirata* Suter, 1908.
—— *dolichostoma* Suter, 1908.
—— *hyphala* Watson, 1886.
—— *fastigiata* Suter, 1907.
—— *incidata* Suter, 1908.
—— *inornata* Suter, 1908.
—— *stygia* Suter, 1913.
—— *murdochi* Suter, 1913.
—— *pudica* Suter, 1908.
—— *takapunaensis* Suter, 1908.
—— *taumakiensis* Suter, 1908.
—— *vestalis* Murdoch, 1905.

Genus Evalea A. Adams, 1860.
Evalea chordata (Suter, 1908).
—— *impolita* (Hutton, 1873).
—— *liricincta* (Suter, 1908).

Genus Pyrgulina A. Adams, 1863.
Pyrgulina rugata (Hutton, 1886).

Genus Menestho Möller, 1842.
Menestho sabulosa (Suter, 1908).

Genus **Subularia** (Monterosato, 1884). [P. 351.]

I have been unable to appreciate the subjection of the species commonly called *Leiostraca* to *Eulima*. I have already pointed out that *Leiostraca* is quite untenable, and that it must be displaced by *Subularia*. In the same place (Proc. Zool. Soc. (Lond.), 1914, p. 673) I noted that *Eulima*, 1826, was antedated by *Melanella*, 1822, and it was only by the acceptance of the generic separation of the "humpbacked" species under *Melanella* that *Eulima* could be preserved as commonly used. The worker who would lump *Subularia* with *Eulima* must needs use *Melanella* for the association, as the latter two are much more closely related than the former two. I would, at present, deny a very close relationship between the species of *Subularia* and those of *Eulima*. I have many species and forms of both under consideration at the present time.

Fam. **Turbinellidae** Sowerby, and Genus **Megalatractus** P. Fischer, 1884. [P. 355.]

These names and the matter relating thereto must be dismissed from the New Zealand molluscan fauna. They were introduced in order that *Siphonalia maxima* Tryon should be there placed, as, according to the investigations of Kesteven (Mem. Austr. Mus., iv, pp. 419–50, 1904), this species was congeneric with *Megalatractus aruanus* (Linné). Kesteven was unacquainted with the anatomy of the Neozelanic shells attributed to "*Siphonalia*," and consequently no comparisons were made in that direction. Minimizing the differences and magnifying the resemblances observed in the animals of the two species he examined, Kesteven concluded that they were congeneric. From a criticism of his work it becomes obvious that Kesteven confused group characters of a much higher value, and that the differences noted were of generic value. The natural sequence of accepting Kesteven's results would be the transference of all the Neozelanic "*Siphonalia*" to the genus *Megalatractus*. If the figures given by Kesteven of the operculum and radula of *Siphonalia maxima* be contrasted with those given by Hutton (Trans. N.Z. Inst., vol. xv, p. 119, pl. xiii, fig. F) for "*S.*" *dilatata* (Quoy and Gaimard), they will be seen to agree in the very details wherein they differ from Kesteven's own figures of the same items of *M. aruanus* (Linné). Kesteven also argued that the protoconchs of *S. maxima* Tryon and *M. aruanus* (Linné) were essentially similar. I entirely disagree with this conclusion, and would consider they showed radical differences. Here again the protoconchs of *S. dilatata* (Q. & G.) and *S. mandarina* (Duclos) are in absolute agreement with those of *S. maxima* Tryon. It will also be noted that Kesteven made no comparisons with true *Siphonalia*, and, consequently, whatever his results, they were prejudiced through overlooking this important item. The results were: *S. maxima* Tryon, *S. mandarina* (Duclos), and *S. dilatata* (Q. & G.) were much more closely related to each other than to *M. aruanus* (Linné), and were not congeneric. If it were admitted that these were congeneric, then Kesteven had not shown any reason for their transference from *Siphonalia*. I had got so far in 1907, and was hoping I might find *M. aruanus* at the Kermadec Islands, but I did not do so.

Upon further investigation at the British Museum I found that *Siphonalia* was introduced for a series of Japanese shells which were quite unlike those referred to this genus-name by Neozelanic and Australian students. The further discussion will be carried on under the name *Verconella*, which

must displace *Siphonalia* on p. 368. Here only must be noted that *Megalatractus* as a member of the family *Turbinellidae* is not a constituent of the Neozelanic fauna.

Genus Taron (Hutton, 1883). [P. 358.]

It was quite unnecessary to reduce Hutton's generic name to a synonym of *Latirus*, and thus also dispose of Hutton's specific name as invalid. *Taron dubius* Hutton, 1883, should be resumed for the species Suter includes as *Latirus huttoni*. Even if the relationship of the species with *Latirus* be admitted, the shell is sufficiently characterized for the genus *Taron* to stand on its own merits. In the British Museum it has two different locations, but neither approach *Latirus*, though as that genus is now shown it is obviously polyphyletic, and segregation is demanded, not the additional congregation of distinctive forms.

Reference to Mr. E. A. Smith, I.S.O., confirmed my conclusion, and he stated he could see little or no relationship with *Latirus*, and Melvill's generic groups are noteworthy for their polymorphic aggregations and are not natural.

Mitra carbonaria (Swainson, 1822). [P. 361.]

Hedley (Proc. Linn. Soc. N.S.W., vol. xxxviii, p. 312, 1913) has added "*Mitra badia* Reeve, Conch. Icon., ii, f. 157. Hab. ? M.C.," from examination of the type, to the synonymy of this species. Suter's remarks as to the occurrence of this species in New Zealand read, "Only worn and empty shells have hitherto been found. The type is from Port Jackson, New South Wales." The specimens I obtained at the Kermadecs were in the same condition, but they fairly well agree with specimens I collected at Port Jackson. I, however, note that, preserved in the British Museum, there are some shells named "*Mitra rutila* A. Ad., New Zealand." It is quite probable that this locality is wrong, but these shells have a superficial resemblance to *Mitra carbonaria* Swainson.

Genus Verconella Iredale. [P. 368.]

Siphonalia is admitted by Suter, three subgenera being recognized—*Siphonalia* s. str., *Penion*, and *Austrofusus*. The typical Japanese species have no close relationship with the Neozelanic species so called, and the genus-name *Siphonalia* must be dropped from the Neozelanic list. The former recall *Cominella*, next to which they are placed in the British Museum, whilst the Neozelanic shells are not associated with them, but placed next to *Fusus* (sensu lato). I advocated in the Proc. Mal. Soc. (Lond.), vol. x, p. 223, 1912, the rejection of *Siphonalia* and the acceptance of *Penion* for the Austro-Neozelanic group, there also stating that *Siphonalia maxima* Tryon must accompany *S. dilatata* (Quoy and Gaimard), and be removed from the genus *Megalatractus*, where Kesteven had placed it through ignorance of the essential differential features of the animals.

Hedley (Biol. Res. "Endeavour," vol. ii, pt. 2, p. 73, 1914) has endorsed my suggestion, recording *Penion maximus* (Tryon) and *P. waitei* (Hedley). Previously Dr. Verco (Trans. Roy. Soc., South Austr., vol. xxxvi, p. 221, 1912 (1913)) had lumped *Siphonalia maxima* Tryon with *S. dilatata* "Quoy and Gaimard." This confirms my conclusion of the very close alliance of these two, as I considered them only congeneric, while Dr. Verco has reduced this grade by making them conspecific.

I have since observed that *Penion* Fischer is invalid, as Philippi had previously used it, and therefore introduced (Proc. Mal. Soc. (Lond.), vol. xi, p. 175, 1914) *Verconella*, with *Fusus dilatatus* Quoy and Gaimard as type. *Austrofusus* Kobelt cannot be used, as the type of that section is quite another style of shell. It looks similar to "*S.*" *mandarina* (Duclos), but examination of the shells shows them to differ considerably, and the resemblance to be similar. I cannot, however, separate "*S.*" *mandarina* Duclos subgenerically from *S. dilatata* (Q. & G.): they agree in every essential detail to me. Martyn's *Buccinum nodosum* is, however, a very different type of shell, and it may later prove generically distinct; in the meanwhile I propose the subgenus-name *Aethocola* for it alone.

My reading of the genus would be,—

Genus VERCONELLA Iredale, 1014. *Verconella* Iredale, Proc. Mal. Soc. (Lond.), vol. xi, p. 175, 1914. Type: *Fusus dilatatus* Quoy and Gaimard. Synonym: *Penion* Fischer, Man. de Conch., p. 625, 1884 (not *Penium* Phillippi, Verh. z. l. Ges. Wien, vol. xv, p. 741, 1865).

Subgenus *Verconella* s. str.

Verconella dilatata (Quoy and Gaimard, 1833).

——— *maxima* (Tryon, 1881).

——— *mandarina* (Duclos, 1831).

——— *valedicta* (Watson, 1886).

——— *caudata* (Quoy and Gaimard, 1833).

Subgenus *Aethocola* nov.

Verconella nodosa (Martyn, 1784).

Cominella eburnea (Reeve). [P. 383.]

This name, according to Suter's synonymy, must displace *Cominella costata* (Quoy and Gaimard), as the basis of that name is *Buccinum costatum*, which is invalidated by the prior usage of Linné (Syst. Nat., ed. x, p. 738, 1758).

Cominella quoyana (A. Adams, 1855). [P. 384.]

Kobelt proposed *Cominella huttoni* for the species so named, as there was a *Buccinum quoyi* Kiener which comes into the same genus, *Cominella*. It has been continually used, but, according to the nomenclatural laws now adhered to, A. Adams's name must be reverted to.

Cominella adspersa (Bruguière, 1789). [P. 385.]

Martyn's *Buccinum maculatum* is invalidated by Linné's prior use (Syst. Nat., ed. x, 1758, p. 741). Bruguière's name comes next, and claims usage.

Fam. Fusidae Iredale. [P. 392.]

I propose this name to replace Dall's family *Colubrariidae*, basing the name upon the oldest genus-name in the family. The following account will clearly show the extreme difficulty and amount of time necessary if one attempts to name a shell correctly both generically and specifically.

When I was investigating the relationships of my genus *Jeannea* (Proc. Mal. Soc. (Lond.), vol. x, p. 220, 1912) it was necessary to fix the genus *Pisania*. The only member I was familiar with was *Pisania reticulata* A. Adams, and my *Jeannea* was nothing like that. Under the genus *Pisania* in the British Museum collection rather an incongruous association of shells appeared, amongst them being *Pisania reticulata*. The type of *Pisania*

of H. Bivona-Bernardi (Effem. Sci. Litt., vol. ii, p. 8, 1832) is *P. striatula* nov. = *B. maculosum* Gmel. That shell was as unlike *Pisania reticulata* as it was dissimilar from my *Jeannea.* It was obvious that Adams's species was unhappily located. Mr. C. Hedley was at that time in England, working through the Australian shells in the British Museum, so I drew his attention to this fact. He at once informed me that he had always been dubious of the generic selection, and that to his eyes *reticulata* suggested *Colubraria.* Upon making comparisons I at once agreed that such would be quite an acceptable relationship, and, moreover, noted that Mr. Edgar Smith had arranged some Australian shells in this genus. Thus *Colubraria bednalli* (Brazier), *C. coxi* (Brazier), and *C. angasi* (Brazier) are all closely related to *Pisania reticulata* A. Adams, the first-named being very near. My own specimens of *P. reticulata* A. Adams show obsolete varices, and the reticulate sculpture is characteristic of *Colubraria* and foreign to *Pisania.*

In the Smith. Miscell. Coll., vol. xlvii, 1904, Dall proposed the family *Colubrariidae* to cover a series of shells varied and showing a resemblance to Tritons, but differing in being rhachiglossate, not taenioglossate. As a subgenus of *Colubraria* was ranked *Cumia* Bivona, 1838, with type *Triton reticulatus* Blainville, and as sections were named *Maculotriton, Monostiolum, Caducifer,* and *Taeniola*, and a subgenus *Phrygiomurex.* The Australian species fall into *Cumia, angasi* being near *reticulatus* Blainville. As a consequence of this conclusion, *Pisania reticulata* must be renamed. However, in the Journ. Conch., vol. xi, p. 289 *et seq.*, 1906, Dall discussed "The Early History of the Generic Name *Fusus*," pointing out that this name was first proposed by Helbling in the Abhandl. Privat Böhm, vol. iv, pp. 116–20, 1779, and that four species were included, the last named being *Murex (Fusus) intertextus* Helbling = *T. reticulatus* Blainville. As causing the least confusion, this was selected as type of *Fusus* Helbling, and this antedates *Cumia* and also *Colubraria.* Dall suggests that these two may prove generically separable, and then *Colubraria* may be preserved for the larger shells. This, however, does not much concern us, as the shell under question is closely related to *Cumia* and not *Colubraria.* The specific name *reticulata* A. Adams cannot, however, be preserved, so that I propose the new name ***Fusus mestayerae*** for *Pisania reticulata* A. Adams.

The other three names I noted—*bednalli, coxi,* and *angasi*—all of Brazier, may need emendation when transferred to *Fusus*, though I have noted that Hedley has ranked the last two, I believe, as synonyms of *antiquatus* Hinds.

Genus Pollia (Sowerby, 1834). [P. 393.]

Suter has retained the genus *Cantharus* Bolten, 1798, for two Neozelanic species, citing as a synonym "*Pollia* Gray, 1839 (in part)." One of the species is placed under *Cantharus* s. str.; the other under *Tritonidea* Swainson, 1840, treated as a subgenus. It seems certain that Suter was not acquainted with *C. tranquebaricus* (Gmel.), otherwise he would not have separated *C. fuscozonatus* Suter from *C. colensoi* Suter to have placed it with that species. Most workers now admit "*Tritonidea*" as a distinct genus, and it is quite impossible to admit subgeneric distinction between the two Neozelanic species. Both would fall into "*Tritonidea*" in preference to *Cantharus*, and I would there place them. The name *Tritonidea* is, however, antedated by *Pollia* Sowerby, and use of the latter must be advocated. I showed (Proc. Mal. Soc. (Lond.), vol. x, p. 221, 1912) that *Pollia* was introduced in Sowerby's Gen. Rec. Fossil Shells, vol. ii, pl. 237, fig. 12, 1834, and that the type (the only species) there mentioned was

Triton undosus Lam. Consequently *Tritonidea* Swainson was six years later, and an absolute synonym. Later (Proc. Mal. Soc. (Lond.), vol. xi, p. 177, 1914) I noted that Swainson had recorded this identity, but preserved his own name on account of a prior *Polia*. But these two names are essentially different. Therefore I should dismiss *Cantharus* from the Neozelanic fauna and replace it by—

Genus POLLIA Sowerby, 1834. *Pollia* Sowerby, Gen. Rec. Fossil Shells, vol. ii, pl. 237, fig. 12, 1834. Type: *Buccinum nodosum*. Synonym: *Tritonidea* Swainson, Treat. Mal., pp. 74, 302, 1840; same type.

Pollia fuscozonata (Suter, 1908).

—— *colensoi* (Suter, 1908).

Alectrion victorianus nom. nov. [P. 397.]

I propose this name for *Buccinum fasciatum* Lamarck, 1822, which is antedated by *Buccinum fasciatum* O. F. Müller (Vermes, vol. ii, p. 145, 1774), and also by Bruguière (Ency. Meth. Vers., vol. i, p. 247, 1789). I have not seen Neozelanic specimens, and therefore note that the name is given to the Australian shell. I believe this shell is the badge of the Field Naturalists' Club of Victoria, and for this reason have formed the above specific name.

In the Man. Conch., vol. iv, as noted by Suter, this species was placed in the subgenus *Hima*. That name I will later show to be unapplicable, but cannot go into details at present; the subject is too complex. This species does not fall into *Alectrion* s. str., but, associated with *A. ephammilla* Watson, would fall into the subgenus which has wrongly borne the name of *Hima*.

Alectrion suturalis Lamarck subsp. dunkeri (Suter, 1908). [P. 398.]

I cannot understand what Suter has done in this case. Apparently he has renamed Dunker's *Nassa intermedia*, but I cannot understand what the shells were that he identified with this form.

At the Kermadecs I rarely collected a shell which occurs abundantly at Lord Howe Island, at Norfolk Island, and rarely in New South Wales. These were recognized by comparison with the types as *Nassa spirata* A. Adams. I recorded this in the Proc. Mal. Soc. (Lond.), vol. ix, p. 77, 1910. Suter's description and habitat agree with these shells, save for the statements, "Usually 3 distant fine brown spiral lines on the spire-whorls, 5 to 7 on the body-whorl." "Outer lip . . . sometimes with 4 to 5 minute teeth near the base." These are characteristics of the "*glans*" group, and do not occur in the hundreds of *A. spiratus* A. Ad. I have before me. Otherwise I should have considered Suter's name as a synonym.

Fam. Muricidae Fleming. [P. 399.]

The nomenclature of the species recognized in this family may be correct, but it is certain that the nomination of higher groupings is inexact.

Under the genus-name *Murex* Linné many groups are confused, and the characters of each are so well defined that they should be considered as of generic value. In the British Museum, an institution famed for its conservatism, this has been accepted, and the species are arranged under many genera. It is quite impossible for me at the present time to revise the group, but I would put on record some of the data I have collated, as it differs from that shown by Suter.

The earliest type-designation of the Linnean *Murex* I have traced is that by Montfort, who in the Conch. Syst., vol. ii, p. 619, 1810, designated *Murex tribulus* Linné as type.

As subgenus (p. 400) *Muricantha* is used, based on *Muricanthus* Swainson, Treat. Mal., 1840, p. 296; as synonyms being quoted *Centronotus* Swainson, 1835 (not of Schneider, 1801), and *Phyllonotus* Swainson, 1840.

On p. 403, as a subgenus, *Pteropurpura* Jousseaume, 1879, is used: as a synonym *Pteronotus* Swainson, 1840, not of Gray, 1838, being cited.

The history of the Swainsonian genera is as follows:—In the Zool. Illus., 2nd ser., vol. iii, 1832–33, Swainson moved thus: In part 22, in connection with plate 100, he subdivided the genus *Murex* into five subgenera—viz., *Murex* Auct., *Haustellaria* Sw., *Phyllonotus* Sw., *Centronolus* Sw., and *Pterynotus* Sw. Diagnoses are given, but no species named. The species in question, however, is figured and described as *Murex* (*Centronotus*) *eurystomus*. In part 24, on pl. 109, is figured and described *Murex* (*Phyllonotus*) *imperialis*, and *Murex pinnatus* is named in connection with *Pyterynotus*. In the 27th part *Murex* (*Pteronotus*) *pinnatus* is figured on pl. 122, earlier described in Bligh's Cat. App., p. 17.

The dates and types of these generic names would read then,—

Centronotus Swainson, Zool. Illus., 2nd ser., vol. iii, pl. 100, 1833. Type (by monotypy): *Murex* (*C.*) *eurystomus*, Sw.

Phyllonotus, id. ib., pl. 109, 1833. Type (by monotypy): *Murex* (*P.*) *imperialis* Sw.

Pteronotus, id. ib., pl. 122, 1833. Type (by monotypy): *Murex pinnatus* Sw.

In the Treatise Mal., 1840, Swainson made several alterations, and this contradictory effort has been generally accepted without criticism, due to ease of reference. On p. 296 *Phyllonotus* Sw. is made to include both *eurystomus* Sw. and *imperialis* Sw., whilst the new name *Muricanthus* is proposed, with two species—*radix* Sw. and *melanomathus*—though it is stated in a footnote, "This type was originally called *Centronotus*; but as that name had been previously given to a genus of fishes, we substitute the above." If Suter's synonymy were correct, then *Phyllonotus* Swainson, 1833, would replace the subgeneric name *Muricantha* Swainson, 1840, on p. 400; and on p. 403 *Pteronotus* Swainson, 1833, would become available instead of *Pteropurpura* Jousseaume, 1879, as it is earlier than *Pteronotus* Gray, 1838. As noted, however, above, these groups seem certainly very well differentiated, and of full generic value. A careful monographic review would probably give many more than I here admit, but there are four distinct groups. Fischer admitted seven subgenera covering these same four. Adams Bros. had recognized ten, but three of these were generically separated from *Murex* by Fischer.

Names not taken intô consideration by Fischer are now commonly recognized, so that his nomination cannot be followed.

T. Martyn, in 1784, introduced *Purpura* for a species of this family, but its first entrance is in connection with a shell (*P. foliata*) which was later made the type of a new genus, *Cerastoma* Conrad, 1865, which name it must displace.

Perry's names *Triplex* and *Hexaplex* call for consideration, so that I have roughed out these names for future workers.

Montfort, in May, 1810, split up *Murex* Linné as follows: *Murex* Linné; type, *M. tribulus* Linné. *Chicoreus* nov., pp. 610–11: type, *M. ramosus*; *Brontes* nov., pp. 622–23; type, *M. haustellum*.

Perry, in June, 1810, independently provided: *Triplex;* type, *T. foliatus:* in December, 1810, *Aranea;* type, *A. gracilis:* and in 1811 *Hexaplex;* type, *H. foliacea:* the last-named being noted in June, 1810, as a *nomen nudum* only.

Of the above names, *Brontes* and *Aranea* cannot be legitimately used, as both are preoccupied.

Swainson, as above recorded, seems to have been the next, recognizing five subgenera, ignoring previous workers, and therefore introducing five new names, thus: *Murex* Auct., *Haustellaria*, *Centronotus*, *Phyllonotus*, and *Pteronotus*. The fifth, *Pteronotus*, seems to have not been previously indicated, and is a valid group. In 1840 Swainson added as distinct genera *Muricidea* and *Vitulina*. These are proposed in the Treat. Mal., p. 64, where the types are named as of the latter, the *Murex vitulinus* of authors and of *Muricidea* p. 65 *Murex magellanicus*. On p. 296 *Muricidea* has seven species noted, whilst on p. 297 *Vitularia* is written. I note this as the latter spelling is commonly used for a distinct group, whilst *Muricidea* was used for a subgenus of *Murex* by H. and A. Adams, though the type-designation of *Swainson* himself makes it an absolute synonym of *Trophon* Montfort, 1810.

The four outstanding genera would seem to bear the following names:—

Murex Linné, Syst. Nat., ed. x, p. 746, 1758. Type: *Murex tribulus* Linné.

Chicoreus Montfort, Conch. Syst., vol. ii, pp. 610–11, 1810. Type: *Murex ramosus* Linné.

Pteronotus Swainson, Zool. Illustr., 2nd ser., vol. iii, 1832–33, pl. 122. Type: *Murex pinnatus* Swainson.

Hexaplex Perry, Conchology, pl. viii, 1811. Type: *H. foliacea*, fig. 4 = *cichoreus* Gmel.

As early synonyms of *Murex* Linné, may be noted *Aranea* Perry, 1810, preoccupied; *Brontes* Montfort, 1810, preoccupied; *Haustellaria* Swainson, 1833; and *Haustellum* H. and A. Adams (ex Klein); and probably many more.

I do not see any more than subgeneric difference in the group typified by *Murex haustellum* Linné, though this was separated generically by Montfort in 1810, and has been given equal rank ever since with the divisions I call genera as above.

Jousseaume, in the Rev. Mag. Zool., 3rd ser., vol. vii, 1879, p. 314 *et seq.*, divided the *Purpuridae* (= *Muricidae*) into very many genera. I give the names here, as they have not been recorded in Waterhouse's "Index Zoologicus" until given in No. ii, where they are given as appearing in "Les Naturalistes," 1883. Jousseaume's names read as follows:—

P. 32: *Purpura* Tournefort. Type: *brandaris* L.
Haustellum Klein. Type: *haustellum* L.
P. 323: *Tubicauda* nov. Type: *brevispina* L.
P. 324: *Acupurpura* nov. (ex Bayle MS.). Type: *tenuispina* Lam.
Siratus nov. Type: *sirat* Adamson.
P. 325: *Paziella* nov. Type: *pazi* Crosse.
Poirieria nov. Type: *zelandicus* Q. & G.
Biplex Perry. Type: *perca* Perry.
P. 326: *Naquetia* nov. Type: *triqueter* Born.
Inermicosta nov. Type: *fasciata* Sow.
Muricanthus Swains. Type: *radix* Gmel.

P. 327 : *Homalocantha* Mörch. Type : *scorpio* L.
Favartia nov. Type : *breviculus* Sow.
P. 328 : *Muricidea* Swains. Type : *hexagonus* L.
Hexaplex Perry. Type : *cichoreus* Gmel.
P. 329 : *Bassia* nov. (ex Bayle MS.). Type : *stainforthii* Reeve.
Phyllonotus Swains. Type : *imperialis* L.
P. 330 : *Euphyllon* nov. Type : *monodon* Sow.
Chicoreus Montf. Type : *ramosus* L.
P. 331 : *Ocinebrellus* nov. Type : *eurypteron* Reeve.
Tritonalia Flem. Type : *erinaceus* L.
Gracillipurpura nov. Type : *strigosus* L.
P. 332 : *Lyropurpura* nov. (ex Bayle MS.). Type : *crassicostata* Desh. (foss.).
Ocinebrina nov. Type : *corallinus* Sacchi.
Hanetia nov. Type : *haneti* Petit.
P. 333 : *Pseudomurex* Monts. Type : *bactreatus* Brocchi.
Heteropurpura nov. (ex Bayle MS.). Type : *polymorphus* Bron. (foss.).
Vitularia Swains. Type : *vitulinus* Lam.
Crassilabrum nov. Type : *crassilabrum* Gray.
P. 334 : *Forreria* nov. Type : *belcheri* Hinds.
Jatova nov. Type : *jatou* Adamson.
Pteropurpura nov. Type : *macropteron* Desh.
Cerastoma Conrad. Type : *nutallii* Conr.
P. 335 : *Pterochelus* nov. Type : *acanthopterus* Lam.
Marchia nov. Type : *clavus* Kien.
P. 336 : *Pteronotus* nov. Type : *pinnatus* Wood.
Purpurellus nov. Type : *gambiensis* Reeve.
Poropteron nov. Type : *uncinarius* Lam.

Then followed a subdivision of *Typhis*, which does not much concern us at the present, and which seems to be less justified; for it must be admitted that Jousseaume's groups are fairly natural, and exist in nature, though I do not consider them as all of generic value.

It will be noted that Jousseaume used *Purpura* as of Tournefort, *Haustellum* as of Klein, and used Adamson's species-names. The three authors named do not now enter into systematic conchological work, as they are all pre-Linnean.

The earliest post-Linnean use of the genus-name *Purpura* is by Martyn, who utilized it in the Tournefortian sense, though in connection with an exotic species, as noted above.

The three Neozelanic species are very difficult to place, being somewhat aberrant however they are viewed. I have been puzzled to generically locate *Murex zelandicus* Quoy and Gaimard, and on Mr. E. A. Smith's suggestion I leave it for the present under *Murex* as here restricted, but would emphasize the use of Jousseaume's name *Poirieria* in connection with it subgenerically, as it shows very distinct characters, and it stands out wherever it is placed in the family *Muricidae*.

Murex octogonus Quoy and Gaimard is just as peculiar, and it does not match easily with any other species. Jousseaume placed it with *Murex stainforthii* Reeve in the genus *Bassia* proposed for this shell. *Bassia* is, however, invalid. In the British Museum collection it has been placed under *Ocinebra*, but it is obviously out of place, and the radula shows the

characters of *Hexaplex*. It may, therefore, be so classed, but a subgeneric name should be used to emphasize the peculiarities of this form. I therefore propose "*Murexsul* subgen. nov.," and name *Murex octogonus* Quoy and Gaimard as type.

The small shells classed about *Murex angasi* (Crosse) certainly fall into *Pteronotus*. Suter placed them in the section *Alipurpura*, but that section differs very little from *Pteronotus* s. str., while the above-named shell was described as a *Typhis*, and has the canal completely closed when adult. Jousseaume proposed *Poropteron* for *Murex uncinarius* Lam., which is undoubtedly congeneric.

The result of this determination would give the following reading of the Neozelanic species :—

Genus MUREX Linné, 1758.
  Subgenus *Poirieria* Jousseaume, 1879.
    Murex zelandicus Quoy and Gaimard, 1833.
Genus HEXAPLEX Perry, 1811.
  Subgenus *Murexsul* nov.
    Hexaplex octogonus (Quoy and Gaimard, 1833).
    ——— ——— var. *umbilicatus* (Ten.-Woods, 1876).
    ——— ——— var. *espinosus* (Hutton, 1886).
Genus PTERONOTUS Swainson, 1833.
  Subgenus *Poropteron* Jousseaume, 1879.
    Pteronotus angasi (Crosse, 1863).
    ——— ——— var. *eos* (Hutton, 1873).

Trophon stangeri (Gray, 1843). [P. 406.]

This name has been rejected by Suter in favour of the prior *Purpura rugosa* Quoy and Gaimard, 1833. It is pleasing to me to find that there is a prior *Purpura rugosa* Lamarck, Anim. sans Verteb., vol. vii, p. 242, 1822, so that we can revert to the above well-known name.

Xymene gen. nov. [P. 410.]

I propose this genus-name, and name *Fusus plebeius* Hutton, 1873, as type. *Kalydon* Hutton, 1884, that would otherwise be used for these shells, is invalidated by the prior *Calydon* J. Thomson, Syst. Ceramb., p. 263, 1864. The two names are absolutely the same, the C and K in this case being interchangeable. These miniature coloured "Trophons" form an easily recognized group to me, but, as observed in the succeeding note, my interpretation is not coincident with that of my friend Mr. Charles Hedley.

Xymene quirindus nom. nov. [P. 415.]

This name is given to replace *Trophon paivae* Suter, p. 415, not *Trophon paivae* Crosse, 1864.

Hedley (Proc. Linn. Soc. N.S.W., vol. xxxviii, 1913, p. 329) has written, "By Tryon, *T. paivae* Crosse was united to *T. hanleyi* Angas, a decision which has misled Australian collectors. . . . Not only are these two clearly distinct (from examination of types), but *T. paivae* . . . should be regarded as a synonym of *T. recurvus*. Probably when Professor Hutton wrote that *Trpohon paivae* belonged to this new genus *Kalydon* he intended to refer to *T. hanleyi*." Then Hedley retained *Trophon recurvus* Philippi in the genus *Trophon*, and used *Kaldyon* (p. 330) for a species which I con-

sider generically distinct from the Neozelanic "*Kalydon*," and which I would unhesitatingly class with *Purpura scobina* Quoy and Gaimard in the genus *Lepsiella*, with that species as type. As a synonym of "*Kalydon*" *vinosus* (Lamarck), Hedley seems to quote *Ricinula adelaidensis* Crosse and Fischer. From the series in the British Museum I assert that this is a distinct species: as far as I can judge, it is an impossible variation.

Under the above circumstances *Trophon recurvus* Philippi would replace *Trophon paivae* Crosse, but two factors intervene. Hedley suggests that Hutton intended *Fusus hanleyi* Angas when he used Crosse's name. When I studied the Australian shells named *Trophon paivae* in the Australian Museum I did not recognize in them the Neozelanic shells so named. The latter, however, resemble *T. paivae* more closely than they do *F. hanleyi* Angas. I consequently propose the above name for the Neozelanic shells, and thus obviate the introduction of an erroneous name into the Neozelanic list. Suter's description does not apply to the types of *paivae* Crosse = *recurvus* Philippi, nor *hanleyi* Angas, all of which I have examined in connection with this note.

Fam. Thaididae Dall. [P. 420.]

The arrangement of the Neozelanic species of this family is probably based on Dr. Dall's paper in the U.S. Geol. Survey, Professional Paper 59, to which Suter refers the Neozelanic student for full synonymy. That paper will not, however, be commonly available to such; and, moreover, it is of such a skeletal nature as to prohibit usage in connection with austral shells. I here give the synopsis provided by Dall, so that my criticisms may be followed by the reader:—

Genus THAIS Bolten, 1798.
 Subgenus *Thais* s. str.
  Section *Thais* s. str. Type: *T. neritoides* = *M. fucus* Gmel.
   Tribulus H. & A. Ad., 1853. Type: *T. planispira* Lam.
   Pinaxia H. & A. Ad., 1853. Type: *T. coronata* H. & A. Ad. = *adamsi* Dall.
   Mancinella Link, 1807. Type: *T. mancinella* Gmel.
   Stramonita Schum., 1817. Type: *T. haemastoma* Linn.
   Lepsia Hutton, 1853. Type: *T. haustrum* Martyn.
   Patellipurpura Dall, nov. Type: *T. patula* Lam.
   Plicopurpura Cossm., 1903. Type: *T. columellaris* Lam.
 Subgenus *Nassa* Bolten, 1798. Type: *T. sertum* Lam.
 Subgenus *Cronia* H. & A. Ad., 1853. Type: *T. amygdala* Kiener.
 Subgenus *Nucella* Bolten, 1798.
  Section *Nucella* s. str. Type: *T. lapillus* Lam.
   Trochia Swains., 1840. Type: *T. cingulata* Linné.

Dall has also given a general synonymy without placing the synonyms under the sections or subgenera. He has stated that the animals vary little, and that shell characters appear to become confused. I think this latter statement is due to the lack of study of juveniles and their growth-stages. If this were undertaken, probably much of the confusion would be dispelled. It must be obvious that in a littoral genus such as *Thais* similar environmental stress must have brought about similar shell-formation in many cases. I have studied the Neozelanic and Australian species through many stages, and I have already expressed my disapproval of the unsatisfactory nature of Dall's classification when applied to austral species.

Dr. Dall courteously wrote me that he was really not well acquainted with these, and hoped that Antipodean workers would deal with them. Previous to the receipt of this letter I had proposed *Lepsiella* for *Purpura scobina* Quoy and Gaimard and *Neothais* (typographical error, *Neothias*) for *Purpura smithi* Brazier.

Suter has synonymized *Lepsia* Hutton, 1884, with *Thais* Bolten, 1798, as an absolute synonym; he then admitted (p. 423) *Stramonita* Schumacher as a subgenus, to which he allotted the species *succinata* (Martyn) and *tritoniformis* (Blainville), not quoting any synonyms, though the latter species has a generic synonymy of its own. A third subgenus, *Nucella* Bolten, is recognized, and thereto is added the species *striata* (Martyn) and *scobina* (Quoy and Gaimard). This sequence cannot be recommended, as the conchological relationship of *T. succinata* (Martyn) and *T. striata* (Martyn) is much greater than that between the former and *T. tritoniformis* (Blainville), or between the latter and *T. scobina* (Quoy and Gaimard). Suter has classed *T. haustrum* (Martyn) in the same subgenus as *T. neritoides* Bolten, and has quoted Troschel's description and figure of the radula. It might be of use to the Neozelanic student to outline Troschel's classification, as this was prepared solely from radular characters, no value at all being given to shell characters. I suggest that a careful consideration of radular characters in conjunction with shell features as governed by growth would lead to a satisfactory arrangement. Troschel admitted five genera, thus:—

Thais nodosa L. (*neritoidea* Lam.).
Purpura patula L.
Tribulus hippocastanum Lam.
—— *deltoidea* Lam.
—— *pica* Blainv.
—— *mancinella* Lam.
—— *bituberculari*s Lam.
Polytropa lapillus L.
—— *dubia* Kr. (*schultzei* Dkr.).
—— *haustrum* Q. & G.
Stramonita chocolata Duclos.
—— *floridana* Conr.
—— *bicostalis* Lam.
—— *undata* Lam.
—— *haemastoma* L.
—— *rustica* Lam.
—— *blainvillei* Desh.
—— *consul* Chem.

This arrangement cannot be confidently criticized, as it has been shown in other groups that the nomination of the species was very inaccurate. In order to emphasize the fact that shell characters and radular characters *do* go hand-in-hand, I would note that *all* the five species Troschel grouped under *Tribulus* were associated together, from shell characters, by H. and A. Adams in their subgenus *Thalessa* (Gen. Rec. Moll., vol. i, p. 127, 1853), and, further, that out of the eight Troschel named in *Stromonita* six appear under the same subgeneric name in H. and A. Adams's work. Further, Troschel placed *haustrum* in a different genus from *neritoides*, associating the former with the British *lapillus*. Almost as bad is Dall's subordination of *Trochia* Swainson to *Nucella* Bolten, which he used for *lapillus* L. Upon

investigation I find that Dall had overlooked the introduction by Perry in his "Conchology" (1811) of the genus *Haustrum*. This genus included several species, of which one was *Haustrum zealandicum* Perry. By tautonymy this becomes the type species of the genus, as it is the species named *Buccinum haustrum* by Martyn in 1784. This name will therefore displace *Lepsia* Hutton, 1883. The acceptance of generic names to indicate the groups seems the most satisfactory method to advocate, as the shells have been so variously grouped. A study of the wanderings of *B. haustrum* Martyn should convince any one of the propriety of this step.

In the family *Thaididae* I would therefore read,—

Genus HAUSTRUM Perry, 1811. *Haustrum* Perry, "Conchology," pl. xliv, 1811. Type: *Buccinum haustrum* Martyn. Synonym: *Lepsia* Hutton, Trans. N.Z. Inst., vol. xvi, p. 222, 1883: same type.

Haustrum haustrum (Martyn, 1784). Synonyms: *B. haustorium* Gmelin, 1791; *Haustrum zealandicum* Perry, 1811.

Genus NEOTHAIS Iredale, 1912 (em.). *Neothias* (error type) Iredale, Proc. Mal. Soc. (Lond.), vol. x, p. 223, 1912. Type: *Purpura smithi* Brazier.

Neothais succincta (Martyn, 1784). Synonyms: *B. orbita* Gmelin, 1791; *P. textiliosa* Lamarck, 1816.

Neothais smithi (Brazier, 1889). Synonym: *P. striata bollonsi* Suter, 1906.

Neothais lacunosa (Bruguière, 1789). Synonyms: *B. striatum* Martyn, 1784, not Pennant, 1777: *P. rugosa* Lamarck, 1820: *P. rupestris* Valenciennes, 1833.

Genus AGNEWIA Tenison-Woods, 1878. *Agnewia* Tenison-Woods, Proc. Roy. Soc. Tasm., 1877, p. 29 (1878). Type: *Purpura tritoniformis* Blainville. Synonym: *Adamsia* Dunker, Proc. Zool. Soc. (Lond.), 1856, p. 357: same type: not *Adamsia* Forbes, 1840.

Agnewia tritoniformis (Blainville, 1833). Synonym: *Adamsia typica* Dunker, 1856.

Genus LEPSIELLA Iredale, 1912. *Lepsiella* Iredale, Proc. Mal. Soc. (Lond.), vol. x, p. 223, 1912. Type: *Purpura scobina* Quoy and Gaimard.

Lepsiella scobina (Quoy and Gaimard, 1833).

—— —— var. *albomarginata* (Deshayes, 1839). Synonyms: *tristis* (Dunker, 1866); *biconica* (Hutton, 1878)

—— —— var. *rutila* (Suter, 1899).

Neothais succincta (Martyn, 1784). [P. 423.]

This species does not occur at the Cape of Good Hope, as given by Suter, but is restricted to the east coast of Australia, as far north as the Peronian region extends, and along the south and west in the limits of the Adelaidean region. It does not extend to New Caledonia, as far as I have traced, but is abundant at Norfolk Island, and very rare at the Kermadecs.

The Cape of Good Hope shell which has been confused with it is *Trochia cingulata* (Linné). The adults bear a superficial resemblance, but the immature and juvenile shells differ entirely, and prove that no close relationship between the two shells, which I place in different genera, exists. The variety "*textiliosa*" puzzles me greatly, as it occurs under the same environmental conditions, and is continually a stouter shell. May the difference be sexual?

Agnewia tritoniformis (Blainville, 1833). [P. 424.]

This shell, described as a *Purpura*, was redescribed with a new generic name *Adamsia*, which, being invalid, was changed to *Agnewia*. Writers desirous of neglecting this name have succeeded in putting it into *Cominella* and *Urosalpinx*. Such diversity of opinion indicates the acceptance of *Agnewia*. Kesteven, prejudiced by the presence of the sinusigera apex, concluded that it must revert to *Purpura*. now *Thais*, where Suter has placed it. In shell characters it stands quite alone, and Dall failed to place it, so ignored it. It agrees with no other *Thais* (sensu lato) I know. It is common on the littoral of New South Wales. where I myself collected it, and abundant as a shore shell at Lord Howe and Norfolk Islands. Its range is coincident with but much less extensive than the preceding, apparently not reaching mid Western Australia, nor did I find it at the Kermadecs.

Neothais lacunosa (Brugière, 1789). [P. 425.]

As noted by Suter, the name he used, *Thais striata* (Martyn, 1784), was invalid through the prior use of Martyn's name by Pennant (Brit. Zool., ed. 4. vol. iv. p. 105, 1777), while that is also antedated by O. F. Müller (Vermes, vol. ii, p. 149, 1774). The above name seems to have the next choice.

I noted in another place that *Buccinum bicostatum* Bruguière, *loc. cit.*, p. 248, was cited as a synonym. As this was ten pages earlier I looked it up, and found that, although Bruguière cited exactly the same figures and descriptions in both places, he described two quite different shells. Suter adds. "Also Kerguelen's Land": I have not yet seen shells so identified from this locality, but it is almost certain that this is wrong. It appears to replace *N. succincta* (Martyn, 1784) in the Neozelanic region. though it cannot be considered an evolutionary product.

Lepsiella scobina (Quoy and Gaimard, 1833). [P. 426.]

This species is confined to New Zealand, and Suter's note, "Tryon says that it occurs at the Cape of Good Hope, and it appears also in Gibbons's 'List of South African Mollusca,' 1888," shows he also doubted its extra-limital occurrence. The South African species so confused is early separable, and has an earlier name than the present one. I have examined specimens, and should class as a nearer ally to the Neozelanic shell the Australian *P. neglecta* Angas, and the shell classed by Hedley (Proc. Linn. Soc. N.S.W., vol. xxxviii, 1913, p. 330) as *Kalydon vinosus* (Lamarck). The fact that the latter has been described as a *Buccinum* (*Ricinula*), *Cominella*, and *Purpura*, and is thence transferred to *Kalydon*, which is not congeneric, shows the necessity of my genus-name *Lepsiella*. As I have shown *ante*, *Kalydon* is invalid, so that recourse may be to *Lepsiella* for the whole group, a course I do not advise.

Neothais smithi (Brazier, 1889). [P. 428.]

Drupa must be omitted from the Neozelanic fauna, as it is included for this species alone. I showed that *Drupa bollonsi* Suter was equivalent to the earlier *Purpura smithi* Brazier, and noted that it was not a *Drupa* at all, but was better classed in *Thais* (sensu lato). Suter (p. 1083) has accepted my specific identification, but has written, "For the present I see no reason why it should not be retained in that genus (*Drupa*)." The

shell is very closely related to *N. lacunosa* (Bruguière), and I know of no species classed in *Drupa* (sensu lato) that approaches it. The type of *Drupa* is representative of a group which is well separated from the small high-spired tuberculose species which the *N. smithi* Brazier vaguely recalls. For this group, which I generically separate, Schumacher's name *Morula* is available. I will elaborate this matter in another place.

Alcira inconstans (Suter, 1906). [P. 442.]

This species was named *Columbella varians* by Hutton (Trans. N.Z. Inst., vol. xvii, 1884, p. 314, pl. 18, fig. 2 (1885)), and as this name was invalid on account of the prior *Columbella varians* Sowerby, Proc. Zool. Soc. (Lond.), 1832, p. 118, it was altered to the above specific name by Suter himself in 1906. The recognition of the species as referable to the genus *Alcira* does not validate the invalid species-name.

Suter has distributed the Neozelanic "Columbellids" in four genera, the genus-name *Columbella* being eliminated from our fauna. I emphatically approve of his action, though it may be that the generic names selected by Suter will not prove the most acceptable when a monographic *résumé* of the family is undertaken. I have many species to study from Lord Howe, Norfolk, and the Kermadec Islands, and will investigate the status of the Neozelanic species at the same time.

Ancilla novaezelandiae (Sowerby, 1859). [P. 453.]

Through an extraordinary mistake this species is named *Ancilla bicolor* Gray, 1847, a remark being given, "The above synonymy is based on information kindly supplied to me by Mr. E. A. Smith, I.S.O., of the British Museum."

Hedley (Proc. Linn. Soc. N.S.W., vol. xxxviii, p. 302, 1913) has indicated how this error occurred, and that *Ancillaria tricolor* was described by Gray at the place given from "Cape York, on sand; cabinet of Mr. Cuming." He also showed that Gray's specific name fell as a synonym of the prior *Ancillaria cingulata* Sowerby, 1830, but that the Australian and Neozelanic species were quite distinct.

Confirmation of Hedley's data shows that the above name becomes valid for the latter, and replaces *Ancilla bicolor* Suter, there being no such species as *A. bicolor* Gray, the name being *A. tricolor* Gray.

Bathytoma zealandica (E. A. Smith, 1877). [P. 491.]

This name must be resumed for the species called *Bathytoma cheesemani* Hutton, 1878, Suter's reason reading, "As Mr. E. A. Smith's species was never figured, I give preference to Hutton's name."

Mangilia? amoena (E. A. Smith, 1884). [P. 502.]

In the same manner this name must be used instead of *Mangilia protensa* Hutton, 1885, selected for the same reason as the preceding by Suter. I have placed a ? after the genus used by Suter, because I have not yet studied this difficult group sufficiently to publish the most acceptable genera to be used for Neozelanic shells. Dall's conclusion is that *Mangilia* is not applicable to the shells commonly so called, but the correct alternative in most cases is not given, his notes only referring to North American species.

Genus **Bullinula** (Swainson, 1840). [P. 521.]

Bullinula Swainson, Treat. Mal., p. 360, 1840, must replace *Bullina* Férussac, 1821, as there is a prior *Bullinus*. Suter has accepted this dictum, as he has used *Cylichnella* instead of *Cylichna* Lovén, 1846, not *Cylichnus* Burmeister, 1844. The above name will be familiar, as it was used in the "Index Faunae Novae-Zealandiae."

Bullinula ziczac (Muhlfeldt, 1818). [P. 522.]

The species-name must also be changed, as *Bulla scabra* Gmelin, 1791, was antedated by O. F. Müller's selection of the same name in the Zool. Dan., vol. ii, p. 90, 1784. The shells in the British Museum have long borne Muhlfeldt's specific name

Genus **Leuconopsis** (Hutton, 1884). [P. 592.]

For the Neozelanic shells Suter has degraded Hutton's genus to the rank of a section under *Leuconia* Gray. It has been overlooked that as long ago as 1903 the latter name was abandoned by British malacologists for the British species. B. B. Woodward, in his "List of Non-marine Mollusca" (Journ. Conch., vol. x, p. 355, 1903), utilized Bivona's name *Ovatella*, writing on p. 361, "*Leuconia* is a synonym, as Gray himself admits in 1847, for *Ovatella* of Bivona, 1832."

As the Australasian group is at present well defined, I cannot see any reason to recommend the adoption of Bivona's name, but would urge the reinstatement of the absolutely correct one, *Leuconopsis* Hutton. As Suter quotes, I would only admit one species as at present known in New Zealand waters.

Genus **Marinula** King, 1831. [Pp. 591, 594.]

When Mr. Hedley was in England I pointed out that *Cremnobates* was synonymous with *Marinula* King, and upon examination of the types of the two genera he concurred in this view. My friend Mr. M. Connolly, during the preparation of his invaluable "Reference List of South African Non-marine Mollusca" (Annals South Afr. Museum, vol. xi, 1912), referred to me as to the status of the Neozelanic forms. We carefully investigated the whole matter, and Connolly will publish the results, many complications intervening. The fact that the two species referred by Hedley and Suter to the genus *Cremnobates*—viz., *M. maindroni* Vélain and *M. nigra* (Philippi) Vélain—are typical *Marinula* at once discredits *Cremnobates*; but the further fact that *Marinula nigra* Philippi is a synonym of *M. pepita* King, the type of *Marinula*, must be convincing proof of its invalidity. As Connolly's paper will be published in South Africa, and will not commonly come under the notice of the Neozelanic student, I might give the following notes suggested by Connolly's MS., which is now before me.

Marinula pepita King, gen. and sp. nov., was described from the Island of Chiloe, South America. The distribution of typical specimens, probably under manuscript names, caused the description of such as *Auricula nigra* Philippi, King's name having meanwhile been twisted on to a Chilian shell superficially agreeing. This transference became universal, and in the British Museum the type set of *Marinula pepita* King bore on the front the name "*nigra* Phil.," whilst distinct shells, not even referable to the genus, were named "*pepita* King." This confusion existed also in France and Germany, and brought about the record of *M. nigra* Phillippi from Tristan da Cunha, &c.

When Hedley and Suter reinstated *Cremnobates* they were confronted with a descrip.ion of the animal of *Marinula* probably drawn up from some other beast. Connolly has persuaded Mr. G. C. Robson to provide an account of the anatomy of the Tristan da Cunha form, and this agrees fairly with that given by Hedley and Suter, but that is too incomplete to make any useful comparisons.

Connolly has defined the limits of *Marinula*, including *Cremnobates*, as antarctic and subantarctic, of circumpolar range, advancing very little to the northward, reaching Moreton Bay in east Australia and the Island of Chiloe in west South America.

The two Neozelanic species of *Marinula* then will be: *Marinula filholi* Hutton, 1878, and *M. parva* (Swainson, 1855); and *Cremnobates* must be cited in the synonymy of *Marinula*.

Genus **Siphonaria** (Sowerby, Jan., 1824). [P. 597.]

As an overlooked synonym, should be added: *Mouretus* Blainville, Dict. Sci. Nat. (Levrault), vol. xxxiii, pp. 161–62, 1824 (after Sowerby). Type: *Mouretus adansonii* Blainville.

Kerguelenia innominata nom. nov. [P. 601.]

Under the name *Siphonaria lateralis* Gould, 1846, Suter has described a shell occurring at the subantarctic islands of New Zealand: for this shell I provide the above name. As a subgenus-name without reference *Liriola* Dall, 1870, is given: but when that name was provided Dall wrote (Am. Journ. Conch., vol. vi, 7th July, 1870, p 32), "typified by *Siphonaria thersites* Cpr.," and the subantarctic shells do not fall into Dall's group.

Rochebrune and Mabille (Miss. Sci. Cap Horn, vol. vi, Zool., H, p. 27, 1889) introduced *Kerguelenia* for *S. redimiculum* Reeve. This name Suter records as a synonym of *S. lateralis* Gould, but would separate *S. tristensis* Leach.

Examination of the British Museum material, where the types of *redimiculum* Reeve, *macgillivrayi* Reeve, *tristensis* Leach, and paratypes of *lateralis* Gould are preserved, gives the following results: *S. lateralis* Gould is quite a distinct species from *redimiculum*, *macgillivrayi*, and *tristensis*, which agree very closely, but seem to be geographical races, according to the series available, quite constant.

The Neozelanic species does not agree, and consequently I have named it as above.

The species of *Kerguelenia* are recognizable at sight, but the genus would seem to include *S. obliquata* Sowerby and *S. australis* Quoy and Gaimard; but the species *S. cookiana* Suter and *S. zelandica* Quoy and Gaimard would be better placed in *Siphonaria*. Suter observes that the radular characters of *S. australis* Q. & G. and *S. zelandica* Q. & G. notably differ.

Suterella gen. nov. [P. 618.]

As a representative of the otherwise extra-limital genus *Fretum*, Suter admits *Helix novarae* Pfeiffer, 1862. The synonymy given indicates the peculiar nature of this mollusc, this being the sixth generic location quoted by Suter, four being his own attempts to place it. This last is quite as unsuitable as any of the preceding, as I have examined typical species of *Fretum* as well as many specimens of the Norfolk Island molluscs unfortunately associated by Sykes with the Fijian shells, which are the true *Fretum*, and the Neozelanic shell shows discord when grouped with these.

The name above given, with *Helix novarae* Pfeiffer as sole species and type, will call attention to the nature of this mollusc, and probably some investigator will endeavour to fix its place in connection with extra-limital species.

Fam. **Flammulinidae** Iredale. [P. 621.]

Suter's classification of the land *Mollusca* is decidedly an improvement on any preceding it, but still emendations must be made. Thus, Suter diagnoses his family *Phenacohelicidae*, and notes, "tail with a mucous pore," as contrasted with the family *Endodontidae* (p. 684), whose chief feature is "no caudal mucous pore."

Study of the Neozelanic land molluscs in connection with my Kermadec molluscs and in conjunction with the majority of Australian species led me to suggest the above family-name (Proc. Mal. Soc. (Lond.), vol. x, p. 382, 1913). I there showed that the presence or absence of a caudal mucous pore was not constant in the "*Endodontidae*," and concluded that it was certainly valueless as a family character. I noted Suter himself had previously indicated this conclusion, so that it should not have been utilized in the present work. I further added that Suter had claimed the nature of the jaw as characteristic of the *Flammulinidae*, and I suggested that shell features would prove of more satisfying value than the evanescent caudal mucous pore. I advocated the recognition of many genera, instead of few, and I now see that Suter has divided the genus *Endodonta* into numerous groups, but has not given these names. I have not carefully studied all these yet, but from a close criticism of the Australian species I found constant characters for separation in the sculpture of the nuclear whorls, the ratio of coiling, the form of the umbilicus, and also adult sculpture, so that I am certain easily recognized groups could be named. I pointed out that Pilsbry's classification, upon which Suter's is based, has been since amended by himself in the manner I propose.

A few criticisms may be hereafter given, but a monographic consideration of the Neozelanic forms must be carried out under a scheme covering Australian and Pacific forms. The latter are very imperfectly known, and I would again emphasize the sometimes overlooked fact that the classification being used by Suter has already been rejected by its author as inadequate. My own remarks in this connection in the paper quoted above have been endorsed by most workers both here and in America. Dr. Pilsbry has written me that recent study of the Sandwich Island "Endodonts" has given him ground for drafting a rearrangement of the Pacific forms, and that he agrees that too much lumping has hitherto been done, and that the caudal mucous pore has been a "will-of-the-wisp."

Phelussa gen. nov. [P. 622.]

Phelussa is here provided to replace *Phacussa* Hutton, 1883, which is preoccupied, and I name *Helix hypopolia* Pfeiffer, 1853, as type of my genus.

The distribution given of the genus by Suter reads, "New Zealand and Tasmania." In this case Suter is probably correct, but when he studied Tasmanian shells his generic locations were not sound, and he has since rejected most.

In this connection he includes Lord Howe Island in the distribution of his family *Phenacohelicidae*, but I have seen no species from that island (nearly one hundred are now known to me) which could reasonably be included in any of the fourteen genera he recognizes in his family. Lord

Howe Island is mentioned only under the genus *Flammulina* (p. 671), but I have seen no species of *Flammulina* from that island or Norfolk Island, also named.

Therasia ? antipoda (Hombron and Jacquinot, 1841). [P. 655.]

Suter accepts the above name as of these authors (1854) in preference to *Helix aucklandica* Le Guillou, Rev. Zool., v, 1842, 140, with the remark, "I accept H. & J.'s. name because they figured the species." This is not a valid reason, and we should, on the score of priority, have had to accept Le Guillou's name had I not observed that Hombron and Jacquinot had published a preliminary description, which appeared before Le Guillou's name. Consequently the above name can be preserved, the earliest reference reading, "*H(elyx) antipoda* Hombron and Jacquinot, Ann. Sci. Nat., 2nd ser., vol. xvi, p. 64, 1841 : Auckland Islands." When the names, accredited to Hombron and Jacquinot, were published in 1854 the recorder was Rousseau, but in the above-noted paper many species were published by Hombron and Jacquinot themselves. This paper seems to have been overlooked.

Flammulina zebra (Le Guillou, 1842). [P. 680.]

Vitrina zebra Le Guillou, Rev. Zool., v, 1842, 136, is placed in the synonymy of *Helix phlogophora* Pfeiffer, 1850, with the remark, "The specific name *zebra* has, no doubt, priority; but, as no figure of the shell was given, I select Pfeiffer's *phlogophora* as being the next in chronological order, and which was figured by Reeve. Moreover, I have not seen Le Guillou's species from the Auckland Islands, which is narrowly umbilicated, and may be distinct from *F. phlogophora.*" Only two courses are open—the usage of Le Guillou's name *zebra*, or its admission into the synonymy of *phlogophora* Pfeiffer with a ?. Suter suggests they are different species. Search at the Auckland Islands is really necessary to determine such a question, and that is not so easy a matter as to write that it should be done.

Genus Endodonta (Albers, 1850). [P. 684.]

I have proposed the rejection of this generic name from the Neozelanic fauna, and this course will sooner or later be adopted, as the worker responsible for its introduction into that fauna has regretted his action, and latterly repudiated it.

Suter has classed thirty-seven species, four subspecies, five varieties, and seven formae under this genus-name. Five subgenera are recognized, and it would have been easy simply to write that these should be recognized as genera; but unfortunately the first two subgenera used by Suter cannot be differentiated by the descriptions he has given, which are copied from Pilsbry's "Guide to the Helices" (Man. Conch., 2nd ser., vol. ix, 1893). In my paper quoted above (the only one I have yet written dealing with Australasian land molluscs) I suggest their identity. I there stated, however, that later many genera might be recognized when the animals were carefully studied in conjunction with their shells. In the meanwhile I would suppress *Thaumatodon* and simply generically use *Ptychodon*. The recognition of *Phenacharopa* as a distinct genus cannot be denied whilst *Aeschrodomus* claims generic rank. *Charopa*, however, covers many generic types, and it is pleasing to read (p. 700) Suter's memo, "In my opinion, only very few of the Tasmanian and Australian species assigned to *Charopa*

really belong to it," as I had written, "It appears doubtful whether typical *Charopa* has yet been recorded" from Australia.

In this subgenus (*Charopa*) Suter distinguishes five groups, and here again he has utilized the protoconch features to a large extent, *exactly as I had done*, though my work was quite independently performed. Inasmuch as the coincidence is fairly exact, and I was working upon Australian material, kindly loaned me by Mr. J. H. Ponsonby, whose collection of these shells is very complete, and also extra-limital Pacific shells, while Suter was criticizing Neozelanic shells, the groups may be considered quite natural, and I here propose some of the generic names I had conferred in my manuscript dealing with Australian shells. Many others will later be proposed by other workers as well as myself. I introduce,—

Egestula gen. nov. Type: *Helix egesta* Gray, 1850.
Fectola gen. nov. Type: *H. infecta* Reeve, 1852.
Mocella gen. nov. Type: *H. corniculum* Reeve, 1852.
Cavellia gen. nov. Type: *H. biconcava* Pfeiffer, 1853.

The genus *Ptychodon* as hereafter admitted is polyphyletic, but none of the species assigned to *Thaumatodon* by Suter agree at all with the type he has named.

My nomination of the genus *Endodonta* of Suter would then read,—

Genus PTYCHODON Ancey, 1888.
Ptychodon cryptobidens (Suter, 1891).
—— *jessica* (Hutton, 1883).
—— *monoplax* (Suter, 1913).
—— *tau* (Pfeiffer, 1862).
—— *varicosa* (Pfeiffer, 1853).
—— *iredalia* (Webster, 1908).
—— *aorangi* (Suter, 1890).
—— *chiltoni* (Suter, 1909).
—— *hectori* (Suter, 1890).
—— *hunuaensis* Suter, 1894.
—— *leiodus* (Hutton, 1883).
—— *microundulata* (Suter, 1890).
—— *minuta* (Suter, 1909).
—— *pseudoleioda* (Suter, 1890).
—— *ureweraensis* (Suter, 1899).
—— *wairarapa* (Suter, 1890).
Genus PHENACHAROPA Pilsbry, 1893.
Phenacharopa novoseelandica (Pfeiffer, 1853).
Genus AESCHRODOMUS Pilsbry, 1892.
Aeschrodomus barbatulus (Reeve, 1852).
—— *stipulatus* (Reeve, 1852).
Genus CHAROPA Albers, 1860.
Charopa anguicula (Reeve, 1852).
—— *montivaga* Suter, 1894.
—— *benhami* (Suter, 1909).
—— *bianca* (Hutton, 1883).
—— *chrysaugeia* (Webster, 1904).
—— *coma* (Gray, 1843).
—— *ochra* (Webster, 1904).
—— *pseudocoma* (Suter, 1894).
—— *titirangiensis* (Suter, 1896).

Genus EGESTULA nov.

Egestula egesta (Gray, 1850).
—— *gaza* (Suter, 1909).
—— *transenna* (Suter, 1904).

Genus FECTOLA nov.

Fectola alpestris (Suter, 1891).
—— *brouni* (Suter, 1891).
—— *buccinella* (Reeve, 1852).
—— *serpentinula* (Suter, 1891).
—— *caputspinulae* (Reeve, 1852).
—— *colensoi* (Suter, 1890).
—— *eremita* (Suter, 1891).
—— *infecta* (Reeve, 1852).
—— *irregularis* (Suter, 1890).
—— *mutabilis* (Suter, 1891).
—— *otagoensis* (Suter, 1899).
—— *reeftonensis* (Suter, 1892).
—— *roseveari* (Suter, 1896).
—— *sterkiana* (Suter, 1891).
—— *subinfecta* (Suter, 1899).
—— *tapirina* (Hutton, 1883).
—— *variecostata* (Suter, 1890).

Genus MOCELLA nov.

Mocella alloia (Webster, 1904).
—— *corniculum* (Reeve, 1852).
—— *kenepuruensis* (Suter, 1909).
—— *prestoni* (Sykes, 1895).
—— *segregata* (Suter, 1894).

Genus CAVELLIA nov.

Cavellia biconcava (Pfeiffer, 1853).
—— *huttoni* (Suter, 1890).
—— *moussoni* (Suter, 1890).
—— *subantialba* (Suter, 1890).
—— *vortex* (Murdoch, 1897).
—— *microrhina* (Suter, 1909).

The association of species is Suter's, and is open to revision.

Genus **Laoma** (Gray, 1840). [P. 733.]

This genus, as utilized by Suter, is obviously polyphyletic. The type is quite unlike the majority of the species associated with it. I have not studied the species sufficiently to give a correct revised grouping. *Phrixgnathus* should be generically utilized at once, whilst my investigation of the Kermadec land molluscs forced me to introduce a new genus *Paralaoma*: the Neoze'anic *Laoma lateumbilicata* seems to fall into this. Suter's groups in this genus under the subgenus *Phrixgnathus* are very artificial, being based on the width of the umbilicus. I believe that study of the apical features will aid in forming a natural grouping of this family also, and I hope to provide such when I indicate the Endodontoid genera, as well as the groups of the *Flammulinidae*, where I have also found the apical features constant and valuable.

Vomanus subgen. nov. [P. 795.]

I provide this name for *Conophora* Hutton, 1879 (em.), from *Konophora*, as there is a prior *Conophorus* Meigen, Mag. f. Insek. (Ill.), ii, p. 268, 1803, and these are undoubtedly the same word. It will be observed here that Suter has used *Conophora* em. for *Konophora* given by Hutton, an exactly parallel case to *Calydon* and *Kalydon*. The latter name was also given by Hutton, who consistently used K, and, though in the present case emendation was made, it was not in the case of *Kalydon*.

The inclusion of the East African *Parmarion? Kersteni* in the family *Athoracophoridae* seems an obvious error, the geographical distribution of the family, without the species, being quite natural. I would constantly query such an entry as being unnatural, considering our present knowledge of slug forms.

Nucula simplex A. Adams. [P. 833.]

From examination of the types preserved in the British Museum, Hedley (Proc. Linn. Soc. N.S.W., vol. xxxviii, p. 263, 1913) has shown the synonymy of *Nucula simplex* A. Adams, *N. strangei* A. Adams, and *N. antipodum* Hanley. He has preserved the first-named, apparently on the score of priority, quoting the years 1856, 1860, and 1860. Suter has, however, given the correct quotation and correct date for the second- viz., 1856. As a matter of fact, the first two names occur on the same page. Nevertheless, Hedley's choice must be maintained, as it has place priority.

The synonymy would read then: *Nucula simplex* A. Adams, Proc. Zool. Soc. (Lond.), 1856, p. 52; *Nucula strangei*, id. ib.; *Nucula antipodum* Hanley, Thes. Conch., vol. iii, p. 159, pl. 230, fig. 155, 1860.

Genus **Nuculana** (Link, 1807). [P. 834.]

This name must supersede *Leda* Schumacher, 1817, or else a new name altogether must be provided for the genus. British conchologists have adopted the former, but Dall advised its rejection, as being simply a substitute name for *Nucula* Lamarck. Jukes-Browne (Journ. Conch., vol. xi, p. 100, 1904) discussed the merits of the two names, but with little access to much literature, and mainly dependent upon second-hand information, no conclusion was reached. Dall's reason for the rejection of *Nuculana* may be sound, but, as Jukes-Browne concludes, "It is, of course, quite possible that some conchologists will dispute Dr. Dall's reading of Link, and no doubt it is a debatable question." I was quite agreeable to accept Dall's judgment, but was about to point out that authors accepting this had failed to reject *Nassaria*, which is absolutely parallel. However, upon referring to Schumacher, to confirm the introduction of *Leda*, I noted the explanation given for its proposal read, "M. de Lamarck a établi un genre sous le nom de *Nucule* (*Nucula*), et prend pour type de son genre la *Nucule nacrée* (*Nucula margaritacea*) ou *l'Arca nucleus* Lin. En examinant soigneusement cette coquille, j'ai trouvé que la charnière a beaucoup plus de rapport avec celle de la Pectoncle; *et c'est pourquoi j'ai changé le nom de son genre en celui que je lui ai donné*." I have italicized the last sentence, as this proves Schumacher's name to stand on exactly the same basis as Link's; or, rather, it is worse off, for Schumacher has admitted that his generic name was purely a substitute for *Nucula* Lamarck, whereas it is simply inferred that Link's was so proposed. Under these circumstances *Leda cannot* be preferred to *Nuculana*, but if the latter be rejected the former must also pass into synonymy. I advise the retention of *Nuculana* in preference to the alternative of using an entirely new name.

Arca decussata (Sowerby, 1833). [P. 848.]

If the species *Byssoarca decussata* Sowerby be included in the genus *Arca*, the division *Barbatia* being considered as a subgenus only, then some other specific name must be utilized, as there is a prior *Arca decussata* Linné, Syst. Nat., ed. x, 1758, p. 694.

Since the preceding lines were penned Mr. E. A. Smith has investigated this matter, and has discovered from examination of the type that the New Zealand shell is quite distinct from Sowerby's species, and is nameless. His report will be published long before this, when he will indicate the differences, which he has pointed out to me, and which are quite obvious and constant when once recognized.

The range given by von Martens is altogether wrong, as the New Zealand species is confined to New Zealand, and differs at sight from the Australian shell.

Suter's usage of the genus *Arca* to cover every *Arca*-like shell is probably due to Dall's influence, but Dall, when he made his subgenera and sections, used these generically in the same place. Such usage is confusing and perplexing, and, if necessary for convenience, the subgenera should be called genera and the sections subgenera. Thus, on p. 849 Suter recognizes a subgenus *Scapharca*, and on p. 850, as a section, is noted *Bathyarca*. The species is then called *Arca cybaea* Hedley. Now, Hedley is no genus-splitter, yet he named the species *Bathyarca cybaea*. This nomination conveys some idea of the nature of the shell, whereas *Arca cybaea* leaves only a vague impression. The group *Bathyarca* is well defined and easily recognizable, and consequently generic rank should be given it, even if only for convenience' sake.

Subgenus Mytilus s. str. [P. 862.]

This must be quoted instead of *Eumytilus* von Ihering, used by Suter. The latter is an absolute synonym of *Mytilus* s. str., and cannot be used under the present nomenclatural laws.

Mytilus maorianus nom. nov. [P. 865.]

I propose this name for the species described by Suter under the name *Mytilus magellanicus* Lamarck, 1819. There is a prior *Mytilus magellanicus* Bolten, Mus. Bolten., p. 158, 1798, based upon Chemnitz Conch. Cab., vol. viii, pl. 83, fig. 738, which is not the present shell. Moreover, specimens in the British Museum from New Zealand differ from South American shells, whilst Purdie showed anatomical differences also.

M. capensis Dunker, given in the synonymy by Suter, does not belong to this species at all, and must be omitted.

Modiolus neozelanicus nom. nov [P. 866.]

Mytilus ater Zelebor is invalidated by the prior *Mytilus ater* Molina, Sag. stor. nat. Chili, 1782, p. 202. The synonyms quoted by Suter—*Perna confusa* Angas, P.Z.S., 1871, 21, pl. 1, f. 33, and *Mytilus crassus* Ten.-Woods, P.R.S. Tasm., 1876 (1877), 157—are not referable to this species, so the Neozelanic species is nameless, and I provide the new name above.

Genus Musculus (Bolten, 1798). [P. 868.]

When Dall (Journ. Conch., vol. xi, pp. 294–97, 1906) reviewed the alterations necessary through the recognition of the Boltenian genera he

wrote, "*Musculus* L. (1. *Anodonta cygnea* L.) = *Anodontites* Brug., 1792 + *Anodonta* Lam., 1799 + *Modiolus* Lam., 1799 + *Modiolaria* Beck, 1840." The reference to *Anodontites* Bruguière, 1792, was probably through the mistaken idea that that genus-name was proposed for a species of *Anodonta* so called. Kennard and Woodward ("List British Non-marine Mollusca," p. 4, 1914) have written, "An attempt having been made by Dr. Haas (Abhandl. Senckenb. Naturf. Gesell., 1910, p. 172) to revive Bruguière's name of *Anadontites* for this genus, it may be as well to point out that the type, *A. crispata* (Journ. Hist. Nat. Paris, 1, 1792, p. 131, pl. viii, figs. 6, 7), is a Guiana shell quite distinct from the European *Anodonta*, and placed by Simpson (Proc. U.S. Nat. Mus., xxii, p. 919) in the genus *Glabaris* Gray (1847), for which it might be used. Lamarck's better-known name is therefore available for the European forms. Therefore *Musculus* cannot be relegated to the synonymy of the earlier *Anodontites*, and, as it is earlier than the other three names mentioned by Dall, demands immediate consideration.

Reference to Bolten (p. 156) shows eight species ranged under the genus-name *Musculus*, thus:

Musculus cygneus = *Anodonta* sp.
— *anatinus* = *Anodonta* sp.
— *compressus* = nomen nudum.
— *discors* = *Modiolaria* sp.
— *novaezeelandiae* = *Modiolaria*
— *moduloides* = *Modiolus* sp.
— *papuanus* = *Modiolus* sp.
— *modulus* = *Modiolus* sp.

It is obvious that the best usage of *Musculus* will be that which will cause the least confusion, and, following the principle of elimination, this name would replace *Modiolaria*. I can see no objection to this course, and therefore designate *Musculus discors* Bolten as type of *Musculus* Bolten. The synonymy will read,—

Genus MUSCULUS Bolten, 1798. *Musculus* Bolten, Mus. Bolten., p. 156, 1798. Type: *M. discors* = *Mytilus discors* Linné. Synonyms: *Modiolaria* Beck, 1840, as quoted by Suter; *Modiolarca* Gray in Dieffenbach's "Travels in New Zealand," vol. ii, p. 259, 1843 (not *Modiolarca* Gray, 1847); *Lanistes* Swainson, 1840, and *Lanistina* Gray, 1847, as given by Suter.

Musculus impactus (Herrmann, 1782). [P. 869.]

To the synonymy add: *Mytilus cor* Martyn, Univ. Conch., vol. ii, pl. 77, 1784; and *Musculus novaezeelandiae* Bolten, Mus. Bolten., 1798, p. 157.

Genus Pecten (Müller, 1776). [P. 873.]

Hereunder is classed, with subgeneric rank only, *Chlamys* Bolten, 1798, and *Pseudamussium* H. and A. Adams, 1858; as a section of the latter, *Cyclopecten* Verrill, 1897, being cited. Although this classification is based upon that of Dall, and has been used by Mr. E. A. Smith in the "Challenger" Report and since, it is not only inconvenient, but I venture to suggest that it transgresses the facts.

The genus *Hinnites* Defrance, 1821 (Dict. Sci. Nat., vol. xxi, p. 169), was proposed for fossils which he contrasted with *Ostrea* and *Spondylus*,

and of which he knew no living representatives. These have since been found, and in the British Museum is a fine series showing complete stages of growth. This genus begins life as a normal *Chlamys*, and then settles down and becomes an irregularly shaped Ostreiform bivalve. Fischer (Man. de Conch., p. 945, 1886) has recorded this transformation. As *Chlamys* has coincidently persisted as a free-swimming form, this proves that *Chlamys* is very ancient, and is fully worthy of generic rank. The close relationship of *Chlamys* and *Hinnites*, two superficially different shells, is proven, but no proof is yet forthcoming that *Chlamys* and *Pecten*, two superficially similar forms, are as closely allied.

Cyclopecten was provided for minute species with a peculiar facies which are recognizable at sight, and their exact relationships seem somewhat obscure. Why such a well-defined group which shows none of the characteristics of the genus *Pecten* should be so classed is a problem I am quite unable to solve.

The nomenclature I would advocate reads,—

Genus PECTEN Müller, 1776.
Pecten medius Lamarck, 1819.
Genus CHLAMYS Bolten, 1798.
Chlamys dichrous (Suter, 1909).
—— *imparicostatus* (Bavay, 1905).
—— *radiatus* (Hutton, 1873).
—— *zelandiae* (Gray, 1843).
—— *convexus* (Quoy and Gaimard, 1835).
Genus CYCLOPECTEN Verrill, 1897.
Cyclopecten aviculoides (E. A. Smith, 1885).
—— *transenna* (Suter, 1913).

In this arrangement I note I am in agreement with Hedley (Mem. Austr. Mus., iv, pp. 303–7, 1902). The reference of all the species to *Pecten*, as Suter has done, would necessitate the rejection of two specific names, as *medius* Lamarck, 1819, and *radiatus* Hutton, 1873, are antedated in the genus *Pecten* (sensu latissimo), but not in my usage.

Pecten gemmulatus (Reeve, 1852). [P. 878.]

This species is recognized as a subspecies of *P. zelandiae* Gray, 1843, but it must be omitted.

Mr. Edgar Smith, I.S.O., dealing with a *Pecten* from New Zealand, asked me if I recognized it. I did not; but as he was getting the species together I took the opportunity of examining the specimens. The types of Reeve's *Pecten gemmulatus* at once attracted me by their strange appearance, and it was soon decided that these were not Neozelanic, as far as we could judge. Though Reeve gave the locality as "New Zealand," the type-tablet bears the original data "Moreton Bay; Strange." Nothing is here known like them, and they disagree in detail with Suter's description of his subspecific form.

Pecten multicostatus Reeve, included by Suter in the synonymy of *P. zelandiae* Gray, must also be omitted, as it is not that shell, and the locality "New Zealand" would appear to be incorrect.

Genus **Gaimardia** (Gould, 1852). [P. 894.]

This name, introduced in the U.S. Expl. Exped., vol. xii, p. 459, 1852, for *M. trapezina* Lamarck, must replace *Modiolarca* Gray, 1847, not *Modio-*

larca Gray, 1843. I have given full details concerning this alteration in the Proc. Mal. Soc. (Lond.), vol. xi, p. 173, 1914.

I doubt the identification of *trapezina* Lamarck from New Zealand, as Suter's measurements do not agree with typical specimens, whilst the specimens I collected at Cape Saunders are certainly not Gould's *pusillus*.

The genus is represented by six species, thus :—

Gaimardia acrobeles (Suter, 1913).
— *pusilla* (Gould, 1850) ?
— *smithi* (Suter, 1913).
— *tasmanica* (Beddome, 1881).
— *trapezina* (Lamarck, 1836) ?
— *minutissima* (Iredale, 1908).

Venericardia purpurata (Deshayes, 1854). [P. 905.]

Hedley (Zool. Res. "Endeavour," pt. i, 1911, p. 97) has drawn attention to the obscurity of *Venericardia australis* Lamarck, and recorded the omission from Neozelanic synonymy of *Cardita quoyi* Deshayes (Proc. Zool. Soc. (Lond.), 1852, p. 103, 1854), given to the Neozelanic shell described by Quoy and Gaimard under Lamarck's name, and which Deshayes determined as different from Lamarck's species. The above name, however, has priority, and has been adopted by Mr. E. A. Smith.

Venericardia lutea (Hutton, 1880). [P. 907.]

Venericardia zelandica Deshayes, 1854, cannot be retained, as it is based on *Cardita zelandica*, which has been used by Potiez and Michaud sixteen years earlier, as Suter himself points out. The above name was used by Hedley in his report on New Zealand bivalves dredged in 100 fathoms, as cited by Suter.

Venericardia unidentata (Basterot, 1825). [P. 908.]

In the synonymy of *Venericardia corbis* Philippi, 1836, is noted the above name without reference. I have traced this name, and it has priority as *Venericardia unidentata* Basterot, Mem. Soc. Hist. Nat., vol. ii, pt. i, 1825, p. 80.

As a subgeneric name, Suter has used *Miodontiscus* Dall, 1903. In the Proc. Mal. Soc. (Lond.), vol. xi, p. 177, 1914, I noted that apparently this should be replaced by *Coripia* De Gregorio, proposed for the present species. Dr. Dall has generously written me that I had overlooked his synonymizing of the latter name with *Pteromeris* Conrad, and his consideration of it as distinct from *Miodontiscus*. I must apologize for my oversight; but, in any case, it means the rejection of *Miodontiscus* in this connection, and I suggest the acceptance of *Coripia* De Gregorio given to this species in preference to Conrad's *Pteromeris*.

Condylocardia (Bernard, 1896). [P. 910.]

The original reference to this genus-name is incorrect. This genus was introduced in the Bull. Mus. d'Hist. Nat. (Paris), vol. ii, p. 195, 1896, and the first species, which in this case must be regarded as type, is *Condylocardia sanctipauli*, described on p. 196. The erroneous spelling given by Suter, "*pauliana*," is due to Dall at the first reference given.

On p. 196 of the same work both *Condylocardia crassicosta* and *C. concentrica* were described from Stewart Island. This number was received at the British Museum on the 10th November, 1896. On p. 194 *Hochstetteria costata*, and on p. 195 *Hochstetteria meleagrina*, are described from the same place. These pages should be added to the incomplete references given on pp. 857 and 859.

I think "St. Helena," given in the distribution of the genus, is incorrect.

Genus **Lucinida** (D'Orbigny, 1847). [P. 912.]

This name, proposed in the Voy. Amér. Mérid. Moll., p. 588, 1847, with type designated as *Lucina cryptella* D'Orbigny, id. ib., must replace *Loripes*. This name is cited by Suter as of Cuvier, 1817; but it was used by Oken (Lehrb. für Naturg., vol. iii, pt. i, p. 231, 1815) two years earlier, and it was originally used by Poli in the Test. Sicil., vol. i, Introd., p. 31, 1795, as a genus-name for the animal of *Tellina lactea* Linné, while the shell was generically named *Loripoderma*. This peculiar double usage of two generic names—one for the animal, the other for the shell—has necessitated the rejection of the Polian names. I find that Dall accepted *Loripes*, and Suter's acceptance is due to his initiative, but in a parallel case Dall rejects *Callista* of Poli. I cannot see any other course open than the rejection of all of Poli's names; the acceptance would necessitate many unpleasant innovations.

Modiolarca minutissima Iredale. [P. 926.]

Omit this name from the synonymy of *Lasaea miliaris* Phil. My shell is a "*Modiolarca*," and a valid species, quite unlike any other member of the genus. I do not understand Suter's reference of it to *Lasaea*.

Kellia balaustina Gould, 1861. [P. 928.]

Omit this name and reference from the synonymy of *Lasaea scalaris* Philippi, 1847. Since Suter so placed it the type has been examined by Hedley, who has recorded (Proc. Linn. Soc. N.S.W., vol. xxxviii, 1913, p. 268) that it is the species he had recently described as *Cyamiomactra nitida* (loc. cit., xxxiii, 1908, p. 477, pl. ix, figs. 19, 20), over which name it has, of course, priority, and has been brought into use

Tellina liliana nom. nov. [P. 948.]

I propose this name for the New Zealand shell described by Quoy and Gaimard under the name *Tellina lactea*, which is invalidated by *Tellina lactea* Linné, Syst. Nat., ed. x, p. 676, 1758. Suter has used *Tellina deltoidalis* Lamarck, proposed for an Australian shell, writing, "I have compared New Zealand and Australian specimens of the same size, and could not find the slightest difference between the two." Nevertheless, with long series the differences are well observed, and Mr. E. A. Smith, I.S.O., of the British Museum, the greatest British authority on bivalve molluscs, unhesitatingly separated the Australian from the Neozelanic species when recently he had occasion to investigate their nomination. He has not published his conclusions, but the shells are named and arranged in the British Museum collection under Lamarck's and Quoy and Gaimard's names

Arcopagia disculus (Deshayes, 1855). [P. 951.]

The species of the group offer such well-marked features that *Arcopagia* needs generic distinction as above, and should not be submerged in *Tellina*. Hedley, whom I have already indicated as inclining to the use of genera of wide limits, has admitted (Proc. Linn. Soc. N.S.W., vol. xxxiv, pp. 433–34, 1909) *Arcopagia* generically.

Tellina gaimardi nom. nov. [P. 952.]

This name must replace *Tellina alba* Quoy and Gaimard, 1835, as there is a prior *Tellina alba* Martyn, Univ. Conch., vol. iv, fig. 157, 1787. All the specimens in the British Museum have been named as above for the last fifty years, but I have been unable to trace this name in literature. Bertin (Nouv. Arch. Mus. d'Hist. Nat. Paris, 2nd ser., vol. i, p. 285, 1878) states that Quoy and Gaimard's type came from New Ireland; but this is obviously an error for New Zealand, as that locality is given by the authors.

Macoma edgari nom. nov. [P. 953.]

Tellina glabrella Deshayes, 1855, was anticipated in usage by Chiaje (Mem. Anim. s. Vert. Napoli, tab. pro. v and vi, 1830, pl. 82), and I propose to rename it as above. The reference to the genus *Macoma* is due to the fact that on the back of the type-tablet Mr. E. A. Smith has noted that the shell must be there placed.

Leptomya perconfusa nom. nov. [P. 956.]

When Mr. E. A. Smith, on Suter's inquiry, showed the shell known to Neozelanic workers as *Tellina strangei* had been incorrectly identified, and was a member of the genus *Leptomya*, Mr. Suter adopted Hutton's specific name from *Tellina lintea*. But that combination had been utilized many years before Hutton chose it by Conrad in the Journ. Ac. Nat. Sci. Philad., 1st ser., vol. i, p. 259, 1837. Instead of Hutton's name, I propose the above as a suitable cognomen.

Fam. Amphidesmatidae Iredale. [P. 956.]

I have found no worse confusion than in the present group called the family *Mesodesmatidae* by Suter, following Dall. Unfortunately, an early error having crept into Dall's researches, the whole matter must be reviewed, and this review has necessitated considerable rearrangement.

Mesodesma was introduced by Deshayes in the Ency. Meth. Vers., vol. ii, p. 441, the title-page of the volume bearing the date 1830; but Sherborn and Woodward (Ann. Mag. Nat. Hist., 7th ser., vol. xvii, p. 579, 1906) have shown that the page quoted was not published until 1832. Seven species are listed, the names and localities being,—

P. 442: *M. donacina* ex Lamarck. New Zealand (Q. & G.).
P. 443: *M. chemnitzii* nov. for Chen. 6, 3, figs. 19, 20. Indian Ocean.
M. quoyi nov. New Zealand (Q. & G.).
M. striata ex Linné. New Holland.
P. 444: *M. donacilla* ex Lamarck. Mediterranean.
M. gaymardi nov. New Zealand (Q. & G.).
M. trigona nov. Praslin Harbour, New Holland.

Deshayes indicated that his genus was proposed for the one Lamarck had designated "Donacille" in 1812, but which that author had submerged in Amphidesma in 1818. Lamarck, in the Extra. d'un Cours. Hist. Nat., p. 107, 1812, named "*Donacille*," but no definition was given and no Latin name, only the vernacular appearing as a *nomen nudum*. In the Hist. Nat. Anim. s. Vert., vol. v, p. 489, July, 1818, the genus *Amphidesma* is proposed by Lamarck, with the explanation, "Depuis assez long-temps, j'avais établi ce genre dans mes cours, sous le nom de donacille (extrait du cours, etc., p. 107), parce que l'espèce que je connus d'abord avait l'aspect d'une donace." The first species is *A. variegata*, the second *A. donacilla*, proposed for *Mactra cornea* Poli, Test. 2, tab. 19, figs. 9 11.

From the preceding it is clear that the name *Amphidesma* was simply substituted for *Donacille*, which was only rejected through its inapplicability to all the species admitted into the genus later. The type of *Amphidesma* must, by tautonymy, be regarded as *A. donacilla*, and this name would come into use vice *Mesodesma*. The earliest latinization of *Donacille* I have traced is in the Dict. Sci. Nat., vol. xiii, p. 428, 1819, where is written, "DONACILLE. *Donacilla* (Conchyl.) M. de Lamarck, dans l'extrait de son Cours, etc., pag. 107, avait donné ce nom de genre à une coquille bivalve, ayant l'aspect d'une donace, qu'il a fait entrer depuis dans le genre qu'il a nommé *Amphidesme*. Hist. Nat. des Anim. sans Vert., 2e édit., t. 5, p. 489. (De B.)."

In the Gen. Rec. Moll., vol. ii, p. 414, March, 1857, as a synonym of *Donacilla* Lamarck is noted "*Donacina* Blainv." Reference to Scudder's Nomenclator, p. 103, gave "*Donacina* Blainv., Moll. 1818, S." The S. means that the name is one added in the supplemental list. On p. 113 of that list I find "*Donacina* Blainville, Dict. Sci. Nat., x, p. 216 (err. typ. ? = *Donacilla ?*), 1818. Moll. Biv." No name at the end of this entry means that Scudder himself was responsible for his addition. I may have been unfortunate, but I have noted that many of Scudder's own entries were erroneous, and reference to the place given shows no mention of anything to do with *Donacina*. So far, the only reference in connection with the name I have found in the Dict. Sci. Nat. is the one given above.

In the Zool. Voy. "Coquille," vol. ii, pt. i, p. 424, 1831, Lesson proposed the new generic name *Paphies*, a contraction for *Paphioides*, as shown by the vernacular, for the Neozelanic shell "*Mya novaezeelandiae* Chemnitz."

My proposition to use *Amphidesma* is based on the fact that the name *Paphies* has priority over *Mesodesma*, and has exactly the same type, for, though Deshayes fixed no type of his genus, Herrmannsen selected (Index Moll., vol. ii, p. 40, 1847) *Mya novaezeelandiae* Chemn. as type, and there is no valid objection to this type-designation. Thus, in any case, *Mesodesma* passes into absolute synonymy.

Taria was proposed by Gray in the Ann. Mag. Nat. Hist., 2nd ser., vol. xi, p. 44, 1853, for *Taria stokesii* n.s. This is a *nomen nudum*, and as type of *Taria* Suter gives *Mesodesma ventricosum* Gray; but in the same place Gray placed his own *ventricosa* in *Paphia*. As two species have been confused, it was necessary to find out what *T. stokesii* was. Search in the British Museum collection, when I was greatly assisted by Mr. E. A. Smith, resulted in the recognition of the type-tablet. The specimen proved somewhat abnormal, but undoubtedly referable to *ventricosa*, which name it bore, and as which it had been recognized by Gray himself; hence its non-publication.

No other names concern us at the present as regards the higher groupings of the Neozelanic shells.

The nomination of the species and groups would read,—

Genus AMPHIDESMA Lamarck, 1818. *Amphidesma* Lamarck, Hist. Nat. Anim. s. Vert., vol. v, p. 489, 1818. Type (by tautonymy): *A. donacilla* Lamarck.

Subgenus *Taria* Gray, 1853.

Amphidesma gaymardi (Deshayes, 1832). Synonyms: *Mesodesma subtriangulata* Griffiths and Pidgeon, 1834; *M. spissa* Reeve, 1854.

— *quoyi* (Deshayes, 1832). Synonym: *Mesodesma lata* Deshayes, 1843.

—— *ventricosum* Gray, 1843. Synonym: *Taria stokesii* Gray, 1853, n.n.

Subgenus *Paphies* Lesson, 1831. Synonym: *Mesodesma* Deshayes, 1832.

Amphidesma australe Gmelin, 1791.

—— — var. *aucklandicum* Martens, 1879.

Amphidesma gaymardi (Deshayes, 1832). [P. 957.]

This is the name to be used for the species included by Suter as *Mesodesma subtriangulatum* Gray, 1825.

First, "*Erycina subtriangulata* Gray, Thomson's Ann. Philos., xxv, 1825," does not occur. Observe that no page is given. In the Ann. Philos. (Thomson), vol. xxv, also quoted in n.s., vol. ix, 1825, Gray gave a list of species not noticed by Lamarck, and on p. 135 is "*Ery(cina) subangulata. Crassatella cuneata* Lam., 483 ?" Note the spelling of the specific name, and, as the above is the complete entry, it is quite obvious that it is a *nomen nudum*. The first synonym, "*Mesodesma latum* Deshayes, 1843," does not belong here: the figure negatives the association instantly. Deshayes wrote "*lata*." Meanwhile, in Griffith and Pidgeon's "Cuvier's Animal Kingdom," on pl. 22, fig. 4, a shell was figured under the name *Mesodesma subtriangulata*. Suter has placed this entry in the synonymy of *Mesodesma australe* Gmelin, 1790, writing, "not of Gray, 1825." I know Suter has never seen this plate, as the figure in no way resembles *Mesodesma australe*. The figure shows a shell quite like the present species, and, allowing for faulty draughtsmanship, is a fairly good illustration. The shell from which the drawing is supposed to have been made, the name being written on the back of the tablet, is still preserved in the British Museum, and is undoubtedly this species. However, in the Ency. Meth. Vers., vol. ii, p. 444, 1832, Deshayes named and fully described *Mesodesma gaymardi* from a specimen brought back from New Zealand by Quoy and Gaimard. In my opinion, no name could be more suitable. I have associated this species with *ventricosum* Deshayes in the subgenus *Taria*, as superficially there does not seem much distinction. Comparing *A. quoyi* (Deshayes) with the present species, I note that both have the siphonal inflection small, whereas *A. ventricosum* has the siphonal inflection deep. Suter, in his definition of *Taria*, copied from Dall, writes, "pallial sinus well marked, sometimes deep." The type of *Amphidesma*, though approaching this species *A. gaymardi*, has a long siphonal inflection, so that it seems a variable character.*

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* I find Lamy (Bull. Mus. Hist. Nat. (Paris), vol. xviii, 1912, has investigated the nomenclature of the Neozelanic forms, and has shown that *Mesodesma lata* Deshayes, 1843 = *M. quoyi* Deshayes, 1830, and that this is quite distinct from *M. ventricosa* Gray. My own results were achieved in ignorance of Lamy's prior work, so that my confirmation is pleasing. Lamy has also gone further than myself with regard to the present species, as he has shown that *subtriangulata* can be retained as of Wood: Index Test. Suppl., pl. i, fig. 10, 1828 (*Mactra*).

The three species *A. gaymardi*, *A. quoyi*, and *A. ventricosum* are associated together under the subgenus *Taria* in the British Museum.

Amphidesma quoyi (Deshayes, 1832). [P. 958.]

Add: *Mesodesma quoyi* Deshayes, Ency. Meth. Vers., vol. ii, p. 443, 1832; *M. lata* Deshayes in Guérin's Mag. Zool. Moll., 1843, pl. 80.

This distinct species is confused in Suter's description of *Mesodesma ventricosum*, while the second name is placed in the synonymy of Suter's *Mesodesma subtriangulatum*. Dall wrote that he could not trace the first name, though it occurred in the same place as the genus-name which he quoted as having referred to! The description given is good, and the words "l'impression du rétracteur des siphons est très-courte" fixes the identity of the species later figured by Deshayes as *M. lata*. Many specimens are here collected by Bolten, Stokes, &c.: they are all named "*lata*," as distinct from "*ventricosa*," which they superficially resemble in size and shape. *A. ventricosa* Gray is longer and narrower than *A. quoyi* Deshayes, and approaches *A. gaimardi* in shape. *A. quoyi* Deshayes has the posterior slope flattened, while in *A. ventricosa* the posterior slope is bicarinate. In *A. quoyi* Deshayes the siphonal inflection is not deep, whilst in *A. ventricosa* Gray it is very deep. Suter, in his definition of *Taria* (p. 958), writes, "pallial sinus well marked, sometimes deep"; but in the species "*M. ventricosum*" he only describes the latter case. Otherwise his description seems to apply to both species, as he does not mention the bicarinate posterior slope, which is distinctly marked in true "*ventricosa*."

A. quoyi Deshayes would enter the same subgenus as *A. gaimardi* Deshayes, but there does not superficially seem subgeneric distinction between these and *A. ventricosum*, the deeper siphonal inflection being the most marked feature.

Fam. Veneridae Leach. [P. 975.]

In this family the nomenclature is that proposed by Dall. This remark refers, of course, to the nomination of the higher groups only. Jukes-Browne, just before his death, completed a synopsis of the family, based upon and severely criticizing Dall's work. This appeared in the Proc. Mal. Soc. (Lond.), vol. xi, pp. 58–94, 1914, and, as this is not generally accessible to the Neozelanic student, I here give a sketch as far as it concerns Neozelanic forms. I would point out that Jukes-Browne's work cannot be accepted *in toto*. Nevertheless, it is possible that a study of Jukes-Browne's papers in conjunction with Dall's results will show that some of the former's corrections are necessary. As, however, Jukes-Brown was dependent upon second-hand information for much of his data, and did not commonly use a microscope, there is still much to be done in connection with these shells. I have given Jukes-Browne's classification, so that comparison can be instituted, and that the New-Zealander may be aware that there has been diversity of opinion regarding the grouping of these shells. Jukes-Brown's system would therefore read,—

Family Veneridae.
  Genus Callista Mörch (after Poli).
    Callista multistriata (Sowerby, 1851).
  Genus Dosinia Scopoli, 1777.
    Section *Austrodosinia* Dall, 1902.
      Dosinia anus (Philippi, 1848).

Family VENERIDAE—*continued*.
Genus DOSINIA—*continued*.
Section *Phacosoma* Jukes-Browne.
Dosinia caerulea (Reeve, 1850).
—— *subrosea* (Gray, 1835).
Genus ANTIGONA Schumacher, 1817.
Subgenus *Clausina* Brown, 1827.
Section *Ventricola* Römer.
Antigona oblonga Hanley, 18—.
Genus VENUS Linné, 1758.
Subgenus *Chione* Megerle, 1811.
Section *Chione* s. str.
Venus stutchburyi Gray, 1828.
Subgenus *Clausinella* Gray
Section *Chamelea* Mörch, 1853.
Venus crassa Quoy and Gaimard, 1835.
Subgenus *Salacia* Jukes-Browne, 1914.
Venus lamellata Lamarck, 1818.
—— *yatei* Gray, 1835.
Genus PROTOTHACA Dall.
Subgenus *Protothaca* s. str.
Protothaca costata Quoy and Gaimard, 1835.
Genus GOMPHINA Mörch, 1853.
Gomphina maorum E. A. Smith, 1902.
Genus TAPES Megerle, 1811.
Subgenus *Amygdala* Römer, 1864.
Tapes intermedia (Quoy and Gaimard, 1835).
Genus VENERUPIS Lamarck, 1818.
Subgenus *Venerupis* s. str.
Venerupis elegans Deshayes, 1854.
Subgenus *Pullastra* Sowerby, 1826.
Venerupis fabagella (Deshayes, 1854).
—— *siliqua* Deshayes, 1854.

The most casual glance will show the discord between the two classifications, and I propose only to note the few errors I have observed with regard to the nomenclature adopted by both. Firstly, Jukes-Browne had not studied some New Zealand species, so that I cannot indicate the positions assigned to every New Zealand Venerid. Secondly, he has rejected Bolten's generic names, and abrogated the law of priority when convenient to his desires.

The co-ordination of the two systems as applied to Neozelanic forms, taking Suter's association of species as approximately correct, and making the necessary alterations in the nomenclature, would read thus :—

Genus DOSINIA Scopoli, 1777.
Section *Dosinia* s. str.
Dosinia lambata (Gould, 1850).
Section *Dosinorbis* Dall, 1902 = *Phacosoma* Jukes-Browne, 1914.
Dosinia caerulea (Reeve, 1850).
—— *subrosea* (Gray, 1835).
Section *Austrodosinia* Dall, 1902.
Dosinia anus (Philippi, 1848).
Section *Dosinisca* Dall, 1902.
Dosinia greyi Zittel, 1864.

Genus MACROCALLISTA Meek, 1876.
Macrocallista multistriata (Sowerby, 1851).
Genus ANTIGONA Schumacher, 1817.
Subgenus *Clausina* Brown, 1827.
Section *Ventricola* Römer.
Antigona creba (Hutton, 1873).
—— *zelandica* (Gray, 1835).
—— *subsulcata* (Suter, 1905).
Genus CHIONE Megerle, 1811.
Subgenus *Chione* s. str.
Chione stutchburyi Wood, 1828.
Subgenus *Clausinella* Gray.
Section *Chamelea* Mörch, 1853.
Chione spissa (Deshayes, 1835).
—— *mesodesma* (Quoy and Gaimard, 1835).
Genus SALACIA Jukes-Browne, 1914.
Salacia disjecta (Perry, 1811).
—— *yatei* (Gray, 1835).
Genus GOMPHINA Mörch, 1853.
Gomphina maorum E. A. Smith, 1902.
Genus PROTOTHACA Dall, 1902.
Protothaca crassicosta (Deshayes, 1835).
Genus PAPHIA Bolten, 1798.
Subgenus *Ruditapes* Chiamenti, 1900.
Paphia intermedia (Quoy and Gaimard, 1835).
—— *fabagella* (Deshayes, 1854).
Genus VENERUPIS Lamarck, 1818.
Venerupis elegans Deshayes, 1854.
—— *reflexa* Gray, 1843.
—— *siliqua* Deshayes, 1854.

I give notes with regard to the emendations proposed, but, as I have not thoroughly studied these shells, the grouping of species is based upon Suter's interpretation of Dall's results. I have, of course, critically examined all the species and the nomination, but more than that is necessary in a difficult group such as this.

Orbiculus (Megerle, 1811). [P. 977.]

This is sectionally used for the species *Dosinia caerulea* (Reeve, 1850), but I have dispensed with it altogether, placing that species under *Dosinorbis* Dall, 1902, of which *Phacosoma* Jukes-Browne, 1914, upon the latter's own premises, must be considered a synonym. He argued that *Dosinorbis* was superfluous, as the characters given by Dall were of little value; he then proposed *Phacosoma* for a well-marked group, and referred the type of *Dosinorbis* to his section. Further, *Pectunculus* Da Costa, 1778, antedates, and is equivalent to *Orbiculus* Megerle, 1811, according to Jukes-Browne and Dall.

Dosinia caerulea (Reeve, 1850). [P. 977.]

As synonyms, Hedley (Proc. Linn. Soc. N.S.W., vol. xxxviii, p. 269, 1913), from examination of types, records *Dosinia diana* A. Adams and Angas, Proc. Zool. Soc. (Lond.), 1863, p. 424; and *Dosinia cydippe* Adams, Proc. Zool. Soc. (Lond.), 1855, p. 224 (1856).

Dosinia subrosea (Gray, 1835). [P. 979.]

As synonyms, Hedley (loc. cit., p. 270) has added *Dosinia coryne* A. Adams, Proc. Zool. Soc. (Lond.), 1855, p. 223 (1856); *D. crocea* Deshayes.

Genus **Antigona** (Schumacher, 1817). [P. 983.]

I have recorded (Proc. Zool. Soc. (Lond.), 1914, p. 668) that when Dall revived *Cytherea* of Bolten, 1798, for this genus he overlooked the fact that it was invalid, as there was a *Cytherea* Fabricius, 1794. I added, *Antigona* was older than *Antigonus* Hübner, quoted as of 1816, but not published until 1820, and therefore the correct name, providing that the other data recorded by Dall and Jukes-Browne and their conclusions were accurate.

I doubt the reference of he Neozelanic shell *Dosina zelandica* Gray to this genus.

Antigona zelandica (Gray, 1835). [P. 985.]

As the basis of *Cytherea oblonga*, Suter has given "*Venus oblonga* Hanley in Wood's Index Test., Suppl., 1828." Wood's Index Test., Suppl., was published in 1828, but Hanley's Descr. Cat. Rec. Shells, also described as a 2nd edition of Wood's Index Test., did not appear until 1842, and was not completed until 1856. On Hanley's Supp., pl. xvi, fig. 1, "*Venus oblonga* Hanley (*Dosina o.* Gray)" was given: this plate was published in 1844. In 1856 the text to this appeared, and on p. 359 *Venus oblonga* Hanley is described. This is simply *Dosina oblonga* Gray, 1843, placed in the genus *Venus*, and as a synonym is quoted "*Dosina zelandica* Gray, 1835, fide Deshayes."

In the Appendix to Yate's Acc. New Zeal., p. 309, Gray describes some new species of shells, one of which was *Dosina zelandica*. The preface to this work is dated the 10th August, 1835. This name has priority, and must now be used. It was dropped on account of the reference of all the species to *Venus* when it clashed with *Venus zelandica* Quoy and Gaimard, published in the same year as Gray's name but earlier. As, however, both were introduced as belonging to different genera, and both are still recognized as referable to distinct genera, both names must be maintained.

When Gray introduced his species he added, "The *Dosinae* have a small anterior additional tooth on the hinge margin. Lamarck refers them to *Venus*: they are intermediate between Venus and *Cytherea*." This is the first introduction of the genus-name *Dosina*, and by monotypy it becomes the type. The name is over twenty years older than *Ventricola* Römer, 1857, used for this section by Jukes-Browne, but cannot be used on account of the prior *Dosinia* Scopoli, 1777. *Dosina* Gray has been generally cited as of 1838, and a different type noted.

Chione spissa (Deshayes, 1835). [P. 991.]

Venus crassa Quoy and Gaimard, 1835, is antedated by *Venus crassa* Gmelin, Syst. Nat., 1791, p. 3288.

Suter's first synonym reads, "*V. spissa*, Deshayes A.s.V., ed. 2, vi, 373 (misprint for *crassa*)." Investigation of this name has given extraordinary results. Reference to Deshayes shows that he was not aware of the specific name given by Quoy and Gaimard, but that he described the shell from the figure given in the "Astrolabe Atlas," and simply translated the vernacular there added. The title-page of the atlas is dated 1833, which indicates that the plates were issued before the text, as that is dated 1835. The vernacular on the plate is *Venus épaisse*, and this Deshayes

translated as *Venus spissa*, and quoted it as of Quoy. When the text was issued, however, Quoy and Gaimard had used *crassa*, both this word and *spissa* being Latin words of similar meanings.

As Quoy and Gaimard's name proves to be invalid, Deshayes's alternative comes into use. The extraordinary part now comes to be related. The last page of Quoy's work bears the date 17th March, 1835, so that it could not have been published before that date. The preface to Deshayes's book is dated the 22nd February, 1835, and, according to the Bibliog. France, it was published before the 7th March, 1835. This gives clear priority to Deshayes's name, and proves that this should have been in use all the time, and, further, that Deshayes's name could not possibly have been a misprint.

Mr. E. A. Smith, I.S.O., of the British Museum, states that he is still unable to separate this species from *C. mesodesma* (Quoy and Gaimard, 1835), which Suter has maintained as a distinct species. If this conclusion, which is justified by the material here, be again confirmed, the name to be used for the combination is *Chione spissa* Deshayes, as shown above.

Hedley (Zool. Res. Fish. Exp. "Endeavour," pt. i, p. 100, 1911) has recorded *Chione mesodesma* (Quoy and Gaimard) for South Australia, noting it as common in Tasmania, and Gatliff and Gabriel and May have also noted its occurrence in Australian waters. "*Venus spurca* Sowerby, P.Z.S., 1835, 23," included in the synonymy by Suter, was not published until April, 1835.

As a subspecies, *violacea* (Quoy and Gaimard, 1835) is admitted by Suter The name is invalid, as Gmelin had proposed this in the Syst. Nat., 1791, p. 3288. I do not, however, think it worth while to provide a new name for such a slight variation.

With regard to the variation, it would be interesting if Hedley, May, or Gabriel would investigate the matter as regards Australia, and record whether the same variation is observed there as Suter has admitted in New Zealand. and settle the usage of *spissa* or the distinction of *mesodesma*.

Protothaca crassicosta (Deshayes, 1835). [P. 996.]

Venus crassicosta Deshayes, Anim. s. Vert., ed. 2, vol. vi, p. 373, 1835, has priority over *Venus costata* Quoy and Gaimard, 1835, which is, moreover, preoccupied by Gmelin (Syst. Nat., 1791, p. 329). This is an absolutely parallel case, as regards nomination, with the preceding, the details being identical.

Suter has omitted the reference to Deshayes, quoting this name as of Hanley; the date 1844 should be added to the reference.

I have followed Jukes-Browne in giving *Protothaca* generic rank. It will be noted that Suter now classes the species in *Paphia* (= *Tapes*), whilst he formerly placed it in *Chione*. When collecting I was puzzled at its inclusion in *Chione*, as in appearance and habits it recalled *Paphia*, and disagreed with *Chione*.

The acceptance of *Protothaca* as a genus seems to satisfy this shell in the best manner.

Genus Gari (Schumacher, 1817). [P. 1002.]

I have been unable to trace a valid reason for the rejection of this name in favour of the later *Psammobia* Lamarck, 1818. *Gari* was proposed by Schumacher (Ess. Nouv. Syst. Test., pp. 44, 131, pl. ix, fig. 2). The type must be *Gari vulgaris* = *Tellina gari* Linné, and this is undoubtedly a

member of this genus. *Gari* has long been used by British malacologists, and probably has been rejected by Austral-Neozelanic workers through the influence of Dall's writings. Under the present nomenclatural laws I am unable to find any cause for its non-acceptance.

I would suggest that possibly the typical species of *Gari* may prove generically separable from species of *Psammobia*, and both may later be preserved; but on the present basis and facts *Gari* claims recognition, and *Psammobia* must pass into disuse generically as a synonym of *Gari*.

Genus **Cleidothaerus** (Stutchbury, 1830). [P. 1033.]

When Stutchbury proposed the above genus-name (Zool. Journ., vol. v, 1830, p. 97) for the species *C. chamoides* (p. 98, Tab. Suppl., xlii, figs. 5–8), from Port Jackson, he gave a footnote reading, "Since this article was sent to press, it has been ascertained that De Roissy has named and characterized this remarkable genus, though evidently from incomplete specimens. He has called it in French '*Camostrée*,' a name so entirely inapplicable that I hesitate not to retain the appellation of *Cleidothaerus*, by which I had designated it. There is nothing in the shell to connect it with *Ostrea*." Reference to the place given by Suter as the introduction of *Chamostrea*—viz., Blainville (Man. de Malac., 1825, p. 632)—shows this to be the introduction noted by Stutchbury of "*Camostrée* de Roissy" only, no Latin name being proposed.

Stutchbury's genus-name must therefore come into use, as *Chamostrea* was not validly proposed until a much later date

Art. XLVIII.—*A Comparison of the Land Molluscan Faunas of the Kermadec Group and Norfolk Island.*

By Tom Iredale.

Communicated by W. R. B. Oliver.

[*Read before the Auckland Institute, 16th December, 1914.*]

I. Introduction.

In the Proceedings of the Malacological Society of London, vol. x, pp. 364–88, 1913, will be found a detailed account of the land molluscs of the Kermadec Group. I had hoped to review this fauna as a zoogeographical item, and contrast it with that of the other island groups which have been generally named in connection with this group—viz., Lord Howe Island and Norfolk Island. But my own collection consisted mostly of minutiae, and I was somewhat surprised to find that the minute molluscan fauna of these groups was unknown. Since then, however, a very large and varied collection of the land molluscs of Norfolk Island has been made by Mr. Roy Bell, my friend and companion collector at the Kermadecs, who has obtained large quantities of minute forms. Still, no general review can be made, as no collections of minute forms are yet known from Lord Howe Island, the Fiji Group, or New Caledonia. As, however, Norfolk Island has always been a favourite study of the Neozelanic zoologist, especially on account of the former existence on that island of species of birds of the Neozelanic, otherwise endemic, genera *Nestor* and *Hemiphaga*, I propose herewith to make a comparison between the land molluscs known from the Kermadecs and from Norfolk Island.

II. List of the Kermadec Group Land Mollusca.

In my collection made at the Kermadecs only twenty species were represented; previous to my arrival at the island six species were on record, and, as two were not recovered by me, sixteen species were added. All these were minute forms.

One of the most interesting results was the discovery that the molluscs were divisible into two groups—one composed of species which lived upon trees, and which were not found on the ground save through adverse circumstances, such as falling leaves; whilst the other group consisted of species which lived under stones, leaves, logs, &c., on the ground, and were never found upon trees. The tree-dwelling molluscs were,—

Helicarion kermadecensis (Smith).
Ptychodon royanus Iredale.
Calymna arboricola Iredale.
Flammulina miserabilis Iredale.
Charopa pseudanguicula Iredale.
Pronesopupa senex Iredale.
Tornatellina sp., a slender form.
—— sp., near *bilamellata* Anton.
Elasmias inconspicua (Brazier).

To the ground were confined,—

Fanulum expositum (Mousson).
Kieconcha kermadeci (Pfeiffer).
Ptychodon pseutes Iredale.
—— *amandus* Iredale.
Charopa macgillivrayana Iredale.
—— *exquisita* Iredale.
Paralaoma raoulensis Iredale.
—— *ambigua* Iredale.
Tornatellina novoseelandica Pfeiffer (? = *subperforata* Suter).
—— sp., a conoid form.

Whilst the twentieth was a semi-amphibious creature recognized as "*Barleeia*"? *chrysomela* Melvill and Standen, described from the Lifu Group. The reason the *Tornatellina* spp. are unnamed is that just after I had examined the species I noted that Dr. Pilsbry, of the Philadelphia Academy of Sciences, had in preparation a monograph of this difficult group, and I therefore at once sent him my material to incorporate in his work. This has not yet appeared, but it will do so in the near future.

III. List of the Norfolk Island Land Mollusca.

The Norfolk Island land *Mollusca* were studied by Sykes from collections at the British Museum, chiefly made by John Macgillivray in 1855, and the results published in the Proc. Mal. Soc. (Lond.), vol. iv, p. 139 *et seq.*, 1900. Twenty-five species were recorded, and the conclusion arrived at was, "As pointed out by Professor Tate and others, the faunal relationship of Norfolk Island lies rather with New Zealand than with the Australian Continent." This sentence would imply the recognition of characteristic New Zealand forms in the Norfolk Island fauna, but the list here given, with Sykes's nomenclature, does not show any such. Sykes recorded,—

Microcystis nux Sykes.
—— *castaneocincta* Sykes.
Trochonanina platysoma Sykes.
Fretum phillipii Gray.
—— *suteri* Sykes.
—— *grayi* Sykes.
Rotula campbellii Gray.
Medyla insculpta Pfeiffer.
—— *imitatrix* Sykes.
Sitala macgillivrayi Sykes.
Carthaea stoddarti Gray (incl. *C. flosculus* Cox).
Charopa exagitans Cox.
Charopa ? depsta Cox.
—— *? quintali* Cox.
—— *? patescens* Cox.
Endodonta norfolkensis Hedley.
Succinea norfolkensis Sykes.
Vertigo norfolkensis Sykes.
Omphalotropis brenchleyi Sykes.
albocarinata Mousson.
cerea Pfeiffer.
navigatorum Pfeiffer.
—— *suteri* Sykes.
Diplommatina coxi H. Adams.
Paludestrina norfolkensis Sykes.

Accepting the generic names used by Sykes, out of fourteen genera admitted only five have been included in the Neozelanic fauna. Two of these five have only scare and doubtful records from the extreme north of New Zealand, two others are the Polynesian *Charopa* and *Endodonta*, whilst the fifth is the Neozelanic endemic *Carthaea*. In this last case there is not a very close resemblance to the New Zealand shell, and the generic location is apparently quite wrong.

It will at once be seen that there is no close relationship between the Kermadec and Norfolk Island faunas when my list and Sykes's are placed side by side. However, as the greater proportion of my forms were minutiae, and as such minutiae were not represented in Sykes's Norfolk Island collection, no critical comparison could be made. What was certain was that Norfolk Island was inhabited by quite a different and more vigorous shell fauna, but the sequel is altogether beyond the imagination of the most sanguine conchologist.

Mr. Roy Bell's collection, which certainly does not include all the forms living on the Norfolk Island group, shows that on the main island over forty distinct species live, whilst some five or six are known as subfossil

only; from Nepean Island, a rock three-quarters of a mile away from the main island, some half-dozen subfossil forms were obtained; whilst the Phillip Island *Mollusca*, through adverse weather, were not collected, and four species are already known from that island. I herewith give the Norfolk Island land molluscan fauna as known from the results of Mr. Roy Bell's collection, worked out by H. B. Preston:—

MAIN ISLAND LIVING MOLLUSCS.

Dendrolamellaria mathewsi Preston.
Advena campbellii (Gray).
—— —— var. *charon* Preston.
Greenwoodoconcha nux (Sykes).
—— *castaneocincta* (Sykes).
—— *tomi* Preston.
Allenoconcha basispiralis Preston.
—— *belli* Preston.
—— *mathewsi* Preston.
—— *monspittensis* Preston.
—— *perdepressa* Preston.
—— *royana* Preston.
—— *congener* Preston.
Roybellia platysoma (Sykes).
—— *depressa* Preston.
Belloconcha norfolkensis Preston.
—— *suteri* (Sykes).
Fanulum insculptum (Pfeiffer).
—— *imitatrix* (Sykes).
—— *testudo* Preston.
Quintalia stoddarti flosculа (Cox).
Mathewsoconcha belli Preston.
Iredaleoconcha inopina Preston.
—— *caloraphe* Preston.
Pittoconcha concinna Preston.
Nitor retinaculum Preston.
Macgillivrayella crystallina Preston.
Cryptocharopa atlantoididea Preston.
Norfolcioconcha norfolkensis Hedley.
Charopa mathewsi Preston.
—— *sororcula* Preston.
Paralaoma orestias Preston.
—— *perminuta* Preston.
—— *depressior* Preston.
Succinea (*Tapada*) *norfolkensis* Sykes.
Nesopupa norfolkensis (Sykes).
Omphalotropis albocarinata Mousson.
—— —— var. *brenchleyi* Sykes.
—— *suteri* Sykes.
—— *cerea* Pfeiffer.
Palaina coxi (H. Adams).
—— *norfolkensis* Preston.
—— *belli* Preston.
Tornatellina norfolkensis norfolkensis Preston.
Tornatellina norfolkensis moohuensis Preston.
Paludestrina norfolkensis Sykes.

COLLECTED BY J. MACGILLIVRAY; NOT OBTAINED BY R. BELL.

Johannesoconcha multivolva Preston.
—— *pusillior* Preston.
Sitala macgillivrayi Sykes.

FOUND SUBFOSSIL, BUT NOT LIVING, ON MAIN ISLAND.

Fretum microstriatum Preston.
Mathewsoconcha albocincta Preston.
—— *vexillum* Preston.
Johannesoconcha minuscula Preston.
Norfolcioconcha iota Preston.

FOUND LIVING ON NEPEAN ISLAND.

Tornatellina norfolkensis nepeanensis Preston.
Tornatellina duplicilamellata Preston.

FOUND SUBFOSSIL, BUT NOT LIVING, ON NEPEAN ISLAND.

Advena campbellii nepeansis Preston.
Quintalia stoddarti nepeansis Preston.
Belloconcha elevata Preston.
Belloconcha compacta Preston.
Succinea nepeanensis Preston.
—— *humerosa* Preston.

PHILLIP ISLAND RECORDS.

Belloconcha phillipii (Gray).	*Advena campbellii campbellii* (Gray).
--- *grayi* (Sykes).	*Quintalia stoddarti stoddarti* (Gray).

INDETERMINATE RECORDS.

Charopa exagitans (Cox).	*Charopa ? quintali* (Cox).
—— *? depsta* (Cox).	—— *? patescens* (Cox).

INTRODUCED SPECIES LIVING ON MAIN ISLAND AND NEPEAN ISLAND.

Vallonia excentrica Sterki (recorded by Sykes as *V. pulchella*).

As a key to Sykes's records the following generic identities must be carefully noted :—

Microcystis Sykes = *Greenwoodoconcha*.	*Charopa* = intermediate spp.
Trochonanina = *Roybellia*.	*Endodonta* = *Norfolcioconcha*.
Fretum = *Belloconcha*.	*Succinea* = *Succinea*.
Rotula = *Advena*.	*Vertigo* = *Nesopupa*.
Medyla = *Fanulum*.	*Omphalotropis* = *Omphalotropis*.
Sitala = *Sitala*.	*Diplommatina* = *Palaina*.
Carthaea = *Quintalia*.	*Paludestrina* = "*Paludestrina*."

I have had the pleasure of critically examining the whole of the material Mr. Roy Bell collected, and I here propose to discuss the affinities of the molluscs.

Like my own Kermadec list, the Norfolk Island list abounds in new generic names, and it is remarkable how extraordinary the difference is between the two lists: in the former "Endodonts" predominate, in the latter they are almost a negligible feature. Zonitoids practically do not exist in New Zealand; two species occurred at the Kermadecs, while they are omnipresent in the Norfolk Island fauna.

IV. DIGEST OF THE KERMADEC LAND MOLLUSCA.

A digest of my Kermadec collection must be first made, then a similar one of the Norfolk Island one, and the results compared. Thus, at the Kermadecs the largest snail-shell was that of *Helicarion kermadecensis* (Smith). As the animal in that genus is large, it was obviously the largest snail. It only occurred to me in one patch at the highest point of the island, though both to Macgillivray and Graeffe it appeared commonly. The shell agrees quite closely in character with that of *H. cuvieri* (Férussac), the Australian shell, which is the type of the genus, and the generic location seems correct. This is mentioned as the genus-name. *Helicarion* has been used to include any glassy, loosely coiled shell, and these have been recently found to cover many diverse genera of snails. I do not admit the occurrence of *Helicarion kermadecensis* (Smith) at Hobson's Glen, Auckland, as there are too many doubtful factors in this record. It would therefore appear that *Helicarion kermadecensis* (Smith) arrived at the Kermadecs from the north. It was the only member of the family *Helicarionidae* which I consider absent otherwise from the New Zealand zoological region.

The next two largest species are referable to the family *Zonitidae*, as used at the present time. This is a wide group, and future systematic work

will materially restrict its limits. One species was introduced as *Trochonanina exposita* by Mousson, the other as *Helix kermandeci* (recte *kermadeci*) by Pfeiffer. For the former I introduced the genus *Fanulum;* for the latter I propose the new genus *Kieconcha*. The peculiar features of the former may be gauged by the fact that it was recently classed in *Medyla* (the correct name of this genus is *Otesia*). the species of which differ entirely in shell characters. It will probably be found to have little relationship with the species hitherto associated with it when the anatomy of the snail is carefully considered. I might add that a report upon the animals of these Kermadec snails is now under consideration, and will probably later appear in these Transactions. The genus *Kieconcha* seemed a necessity, as previously the species had been classed first in *Microcystis* and then in *Macrochlamys*. The first was easily seen to differ entirely in shell characters, whilst the latter has been shown to be restricted to India. *Kieconcha* somewhat recalls the north Australian *Nitor*. If this suggestion should be confirmed it may have been a companion with *Helicarion* from the north. Nothing like *Kieconcha* or *Fanulum* otherwise occur in the New Zealand biological region.

Ten species were obtained which may be classed in the family *Endodontidae*, as that term was used by Pilsbry. I have already given my reasons for objecting to such a group, and so far I have received little but encouragement in the course I adopted. I am now making a conchological survey of the Australasian "Endodonts," so will defer my further remarks until a future date.

I included three species in *Ptychodon*, pointing out that the usage of *Thaumatodon*, unless restricted genera were utilized, was incorrect. My largest species was of the aspect of *Thaumatodon*, whilst the two lesser were of quite a different nature. Three species were ranked under *Charopa*, but here again three different styles of shell were included, and the main reason for so classing them was the unarmed mouth. For one flattened widely umbilicated shell I introduced the subgeneric name *Discocharopa*, as I found a similarly formed species in every detail occurred in so far away a locality as Bass Strait. I have since recognized the same subgeneric form in Queensland. The *Ptychodon* which I would consider of *Thaumatodon* aspect is a Polynesian form of shell, whilst the other *Ptychodon* are nearly related to New Zealand species. All significance of the latter fact is minimized by our entire ignorance of the minute forms which must abound in Polynesia. Research may show this latter *Ptychodon* to be quite common in the northern island groups.

The same remarks apply to the Charopoid forms, and even more forcibly to the two tree-dwelling species I classed in the "Flammulinoid" section of the *Endodontidae*. I suggested that this section should be given family rank as the family *Flammulinidae*, but so far apparently no anatomical features are known whereby a diagnosis can be prepared.

For two species I introduced a new generic name, *Paralaoma*. Since my paper was completed I have studied the Norfolk Island molluscs, and, making comparisons, I believe that three species of this genus may be distinguished at the Kermadecs. However, I include this genus with misgiving in the family *Endodontidae*, and have noted its wide range throughout eastern Australia, where it seems to be well represented. According to one authority, the species I would allot to *Paralaoma* could be classed in *Phrixgnathus*, whilst another claims their near relationship to *Flammulina* Such diversity of location sufficiently excuses a new generic term.

A minute tree-dwelling pupoid form would have been classed in *Nesopupa* save for the fact that the mouth was unarmed. Almost facsimiles, but with fully armed aperture, have been examined from Tahiti. I drew attention to the lack of arming in the aperture by creating the new genus *Pronesopupa*, thereby suggesting the greater antiquity of my shell. I did this as I noted that juvenile Tahitian shells were similarly unarmed. *Nesopupa* and its allies are typically Polynesian, no form whatever being known from New Zealand. The Tornatellinids are unnamed, for reasons given; but I studied them a little, and I can state that of the five species three were typically Polynesian, whilst Suter has recorded one as occurring at the Kermadecs and north New Zealand. In the latter case it may have only recently reached New Zealand, as undoubtedly the fifth, which is referable to a very distinct genus, *Elasmias*, is at present being carried about the Pacific. I strongly feel that it is a comparatively recent settler on the Kermadecs, and, as it is very rare at Lord Howe Island, may have also recently arrived there.

This review will indicate that the Kermadec land *Mollusca* tell us very little, save that they apparently show their source to have been northern in preference to southern. When contrasted with the Norfolk Island molluscs much more will be seen.

V. Digest of the Norfolk Island Land Mollusca.

The Norfolk Island main-island living forms are of most interest in this connection; and, firstly, *Dendrolamellaria matthewsi* is of peculiar value, as this is a species perhaps referable to the family *Helicarionidae*, but of such peculiarities in the shell alone that *Dendrolamellaria* would appear justifiable as a genus. It recalls the marine genus *Lamellaria* in form, and is quite unlike the Kermadec *Helicarion* in every detail. Its ancestry at the present moment is quite obscure.

Advena campbellii is what has been known as *Rotula campbellii*. The shell differs in character from that of *Rotula*, which, moreover, is a genus confined to Mauritius. It is a fine handsome shell, and its character can be estimated from the fact that its nearest relative was ever supposed to be the Mauritius shell. Anatomical study may later give us some clue to its affinity.

The three species classed in *Greenwoodoconcha* are such as are often referred to *Microcystis*, and one recalls that genus, which was first described from Pitcairn Island, in its colour-markings. These shells are, however, somewhat solid. The half-dozen species of *Allenoconcha* would probably also have been placed under *Microcystis*, but they differ appreciably in shell characters, and the shells are very fragile. One species of Microcystine shell has been classed under the north Australian genus *Nitor*, as the shell features agree quite closely with that genus. None of these Microcystine genera closely resemble the Kermadec *Kieconcha*, the *Nitor* having the most likeness.

A most beautiful species was called *Trochonanina platysoma* by Sykes. Another species has been discovered by Mr. Roy Bell, and for these the genus *Roybellia* has been formed. The shell, in its depressed shape, recalls *Fametesta mirabilis* Pilsbry, from the Bonin Group, but upon comparison the Norfolk Island species is found to differ in texture entirely, being a much more beautiful and delicate shell. As animals have been preserved, we shall later learn of the affinities of this remarkable form. It vaguely suggests itself as a relation of *Fanulum*.

As above noted, I introduced this genus-name for a smooth Kermadec shell, and at the present time three Norfolk Island shells are associated with it under my genus-name. Two of these are heavily sculptured, but the third is smooth. I now doubt that these are congeneric with *Fanulum*, as they all have a toothed and callused columella, though varying in shape and sculpture. The report upon the anatomy of the species will settle this point.

Sykes proposed *Fretum* to cover a series of Norfolk Island shells, but selected as type a Fijian species. This is not considered congeneric, so that *Belloconcha* is made use of to indicate these Norfolk Island species, whose generic affinity, however, would seem to be the Fijian *Fretum*.

Quintalia has been introduced as a genus-name for the species Sykes classed under the New Zealand endemic genus *Carthaea*. I cannot see any reason, from a study of shell characters, for the association of these two. *Carthaea*, moreover, is placed in the *Endodontidae*, whereas I would not so class *Quintalia*.

Three extraordinary genera are represented in *Mathewsoconcha*, *Iredaleoconcha*, and *Pittoconcha*. Few specimens have yet been obtained, but they all show quaint features. *Mathewsoconcha* recalls *Belloconcha* in form, but it has a callused semi-toothed columella. *Iredaleoconcha* recalls Philippine shells in general appearance, being somewhat flattened, keeled with convex base, but it has a deeply channelled suture. A shell of very similar appearance has been lately obtained near Obi, in the Moluccas. *Pittoconcha* is a small, somewhat conical, heavily sculptured shell, suggestive of the style of sculpture seen in the Lord Howe species *howinsulae*.

Macgillivrayella is a crystalline flattened Zonitoid of ordinary appearance, yet quite unlike anything yet known.

The preceding completes the Zonitoids as at present known living on Norfolk Island, but Macgillivray collected three very minute forms which Mr. Roy Bell did not obtain. One of these seems a typical *Sitala* as that genus is represented in Fiji, whilst the other two are called *Johannesoconcha*, and are quite remarkable minute forms, glossy and many-whorled; nothing has yet been collected from the north with which *Johannesoconcha* can be compared.

A shell of a Charopoid facies, but which plasters itself over with mud, has been called *Cryptocharopa*. It is somewhat doubtful what its affinities are, but some molluscs in New Caledonia indulge in the same mud-plastering habits.

The "Endodonts" are minute and very sparsely developed; they number six if *Paralaoma* be considered such, but three only otherwise. One which has an armed aperture, and would be broadly classed in *Ptychodon*, has been generically termed *Norfolcioconcha*, as it does not fit well in with either *Ptychodon* (typical), *Thaumatodon*, *Nesophila*, or any other section. The other two are flat discoidal unarmed forms which are classed in *Charopa*. It is somewhat remarkable that these three do not come at all close to the Kermadec "Endodonts"; but here again ignorance of northern minutiae forbids investigation into their affinities.

My genus *Paralaoma*, instituted for Kermadec species, is represented by three forms, but as this genus is somewhat commonly distributed in eastern Australia no great stress can be laid upon this fact. I suggest that its discovery in northern groups may be confidently anticipated. It seems a well-defined and easily recognizable genus, and I look forward to the investigation of its anatomy with great interest.

A species of *Succinea* lives on Norfolk Island; this genus is absent from the Kermadecs and New Zealand, though present in Australia and the northern groups.

The Polynesian genus *Nesopupa* is represented by a large sinistral species with the mouth well armed, and quite unlike the Kermadec dextral unarmed form I have called *Pronesopupa*. No relation of either form occurs in New Zealand.

The Polynesian *Omphalotropis* is well developed, three species and one variety being admitted; these species are closely allied to Fijian forms. No member of this genus was found at the Kermadecs, though one species has been recorded from the extreme north of New Zealand; but the record is somewhat doubtful.

The family *Diplommatinidae* is also credited with three representatives, all belonging to the genus *Palaina*. This is purely a Polynesian group; a solitary species appears on the New Zealand list, but will be almost certainly omitted in the near future, and no member of the family occurs at the Kermadecs.

Two subspecies only of *Tornatellina* have been recognized, one of which is confined to the Moohu Stone, a rocky islet off the north coast. The peculiar item of note is that this species is not close to any of the five distinct species I obtained at the Kermadecs, but recalls a Fijian species.

A "*Paludestrina*" concludes the list of living molluscs obtained on Norfolk Island. I am unable to give any idea of its relations, save that it differs obviously from the New Zealand *Potamopyrgus*, and no fresh-water univalve was obtained at the Kermadecs. Of as great, or even greater, interest were the shells collected as subfossil from the limestone quarry at the south of the island, near Kingston.

Associated with living forms such as *Succinea norfolkensis* Sykes, *Omphalotropis albocarinata* Mousson, *Quintalia stoddarti floscula* (Cox), *Fanulum insculptum* (Pfeiffer), *Fanulum imitatrix* (Sykes), *Advena campbellii* (Gray), *Greenwoodoconcha castaneocincta* (Sykes), were numerous shells apparently now quite extinct. The largest shells are the next in size to *Advena campbellii* (Gray), and are of remarkable interest, as being, from a very close criticism of shell characters, strictly referable to the Fijian genus *Fretum*. Smaller shells are apparently typical *Mathewsoconcha*; and in this connection it is worthy of note that the living species of this genus is, as far as is at present known, exceedingly rare. From sand contained in these subfossils two minute species were sorted out—one a *Johannesoconcha*, the other a *Norfolcioconcha*—both of which differ from the living species.

Still more peculiar is a large quantity of dead shells collected on Nepean Island. This island is only three-quarters of a mile distant, and is apparently devoid of vegetation. Three living species were obtained—two species of *Tornatellina*, and the third *Vallonia excentrica* Sterki, an introduced European form. This latter species has acclimatized itself on Norfolk Island, and by some means has reached this inhabitable islet, and is now flourishing there. The two species of *Tornatellina* are interesting, as one of them is only subspecifically distinct from the Norfolk Island species, whilst the other is quite different, yet has not been discovered on Norfolk Island. It does not come near the Kermadec species. The dead shells are, however, of an extraordinary nature; the large bulk is composed of two species of *Bellooconcha*, differing appreciably from the main-island species.

The next most numerous shell is a large form of *Quintalia stoddarti*, intermediate between *Q. s. stoddarti* (Gray) from Phillip Island and *Q. s. floscula* (Cox) from the main island.

A rarer shell is a fine large variety of *Advena campbellii* called *Advena campbelli nepeansis*. It is much larger and more flattened that either the Phillip Island or main-island forms.

Succinea is well represented, and at the present time it is impossible to decide the truth regarding these. Two species are separated, a very large slender elongate form called *Succinea nepeanensis*, and a more common one with shouldered whorls named *Succinea humerosa*. This might be best considered as the representative subspecies of the mainland *S. norfolkensis* Sykes, than which it averages larger in size.

Omphalotropis is also fairly well represented, but the variation in sculpture and form known in this genus has prohibited the differentiation of the Nepean Island subfossils.

One of the most interesting items to me was the discovery of *Fanulum insculptum* (Pfeiffer), occurring rarely; whilst one specimen of *Fanulum imitatrix* (Sykes) was observed. Altogether a number of the *F. insculptum* (Pfeiffer) were separated, and, though they have not been named, they average smaller and more conical than the living main-island form.

The reason for the extinction of these Nepean Island molluscs is at present unknown, but the facts seem to show that the species formerly living were of larger size than the present existing species, whilst the *Fanulum* seems to show the reverse· that is, the examination of the available material, which is not small, tends to the conclusion that whereas *Advena*, *Quintalia*, and *Mathewsoconcha* (probably also *Succinea*) have decreased in size or become extinct, *Fanulum* has increased in size and numbers, but whether at the expense of the other genera is not evident.

Mr. Roy Bell was unable to collect on Phillip Island, but four species have been described from that locality-- viz., *Belloconcha phillipii* (Gray). *Belloconcha grayi* (Sykes), *Advena campbellii* (Gray), and *Quintalia stoddarti* (Gray). The latter two are still represented on both Nepean Island and the main island, but the exact relationships of these are not known. The type set of *Quintalia stoddarti* (Gray) are much larger than the very long series from Nepean Island, which again greatly exceed in size the living main-island shells, which also differ in their more conical form. These three are ranked as subspecies only, and there seems little doubt as to the accuracy of this determination. The type, however, of *Advena campbellii* (Gray) is a small shell not much larger than the living main-island form. As the subfossil Nepean Island shells are much larger and more depressed. the suggestion at once occurs that the type from Phillip Island may not be representative of the form there living.

The species *Belloconcha phillipii* (Gray) is the giant of the genus, whilst *Belloconcha grayi* (Sykes) is also a large species. These both surpass the subfossil Nepean Island species, whilst on the main island only one small species has been found alive, and so far with very restricted habitat, though two other small species have been found subfossil.

I hope later to be able to record the results of a new search for Phillip Island molluscs, and note their relationships.

It remains to note that four species recorded by Sykes were not obtained by Roy Bell--viz., *Charopa exagitans* (Cox), *C.? depsta* (Cox), *C.? quintali* (Cox), and *C.? patescens* (Cox). From the published de-

scriptions and figures, none of these can be referable to *Charopa* as now understood, and they can only be considered as very doubtful constituents of the Norfolk Island fauna.

VI. Review and Conclusions.

The conclusions to be drawn from these digests can now be summarized, and strongly indicate the different origin of the land molluscan faunas of the two groups. Whereas the Kermadec series alone did not tell much, when contrasted with the Norfolk Island collection quite a deal can be determined. The apparent source of the Kermadec molluscs is Polynesia, the Neozelanic element being quite probably also of that origin, having arrived from the north. It might here be observed that, whilst the *Endodontidae* have been sometimes claimed as an Antarctic group, equally strong claims have been made for their northern origin. Two masters in the science of drawing deductions from observations made on the distribution of land molluscs have differed on this point. I would suggest that correlation might be brought about were restricted groups utilized. As far as my own observations have yet proceeded, I find groups giving an Antarctic range, whilst other groups as surely show a northern origin. Thus in the Kermadecs the "*Thaumatodon*" group emphasizes a northern source, whilst just as surely the "*Discocharopa*" group suggests a southern origin. I hope to deal with such questions in more detail later, giving facts in support of these suggestions.

The most casual examination of the Norfolk Island land *Mollusca* prohibits any idea of the attachment of this fauna to that of New Zealand. The preponderance of Zonitoids and the scarcity of "Endodonts" are equally assertive, whilst the nature of the Zonitoids suggests at once Fiji as a source of supply. The lack of *Placostylus* is somewhat extraordinary, whilst, though no species on the Fijian Group recalls *Advena*, it must be remembered that the Fijian Group has also suffered such vicissitudes as would easily account for the extinction of its relations, if any evér existed there. The presence of a subfossil inseparable in shell characters from the Fijian genus *Fretum* is noteworthy, especially as there appears little doubt that *Belloconcha* is a closely allied genus. This genus would seem to have been the predominant Norfolk Island mollusc, though now *Fanulum* appears to have taken this place. The extraordinary *Roybellia*, I have suggested, may be allied to *Fanulum*. The exact relationships of the other Zonitoids is difficult to suggest, as so little is known of the Polynesian minutiae. The Microcystine genera *Greenwoodoconcha* and *Allenoconcha* are certainly closely allied to "*Microcystis*" and the varied Polynesian shells commonly known under that genus-name. The *Omphalotropis*, *Palaina*, and *Nesopupa* are very closely allied to Fijian and other Polynesian species. Indeed, I suggest that longer series from other localities would cause their degradation to the rank of subspecies only.

Though Norfolk Island is situated somewhat midway between New Caledonia and New Zealand, and in recent charts soundings show the presence of a submerged ridge connecting the three, the land molluscs prohibit any direct connection between the three, whilst they just as surely point to a junction in some way or other with the Fijian Group. I make this reservation as, though *Placostylus* has reached that group, it has not been found Recent or fossil on Norfolk Island.

Though I have not introduced any mention of the Lord Howe Island land *Mollusca*, I would simply note that Hedley pointed out these were

of New Caledonian origin, and my own studies amply confirm this. I hope to supply a detailed account of these later, but would state that they differ totally from those of the Kermadecs, Norfolk Island, or New Zealand, whilst they agree in much detail with New Caledonian land molluscs.

My results are,—

The Kermadec land *Mollusca* are few in species and very minute. The few Zonitoids and comparative abundance of the "Endodonts," the absence of *Omphalotropis* and *Palaina* whilst Tornatellinids are fairly abundant, indicate the lack of any recent land connection, but suggest the recent peopling of the group by means of drift.

The nature of the molluscs incline the direction of the drift to be from the north. The conclusion that the present land molluscs would force the inclusion of the Kermadec Group under the term "Oceanic islands" would also suggest its inclusion in whatever biological region the other groups favoured. The northward-drift tendency at once suggests Polynesia, but the combined results of other studies favour New Zealand. If the latter be accepted, the separation I have indicated elsewhere of the group as a distinct province is amply confirmed by the criticism of the land *Mollusca.*

The Norfolk Island land *Mollusca* are numerous, varied in species and genera; they strongly indicate recent and practically undisturbed land connection. The nature of the land molluscs, however, at once derides any suggestion that this has been with either New Zealand or New Caledonia, whilst it just as strongly formulates an immensely strong claim for this to have been with the Fijian Group.

The Lord Howe land *Mollusca* are fairly numerous in species and genera, and many of large size; they confirm recent land connection, and leave no doubt as to its former attachment to New Caledonia, whilst they prohibit any land connection thereof with New Zealand. They will be fully discussed later; but, as far as land molluscs are concerned, there is not the slightest reason for their quotation in favour of a Neozelanic connection. I note this as they have been so affirmed by writers ignorant of the two land molluscan faunas, and who have simply based their conjecture upon the occurrence of *Placostylus* on both islands, though every other land mollusc plainly indicates the contrary.

I am forwarding with this paper a series of land molluscs from Norfolk Island to be deposited in the Auckland Museum, where those interested can study them and criticize my assertions.

ART. XLIX.—*The* Mollusca *of the Kermadec Islands.*

By W. R. B. OLIVER.

[*Read before the Auckland Institute, 16th December, 1914.*]

Plates IX–XII.

THE Kermadec Islands form an isolated group in the south-west Pacific Ocean, situated about midway between New Zealand and the Tonga Group. They extend from Sunday Island, in S. lat. 29° 15′, W. long. 177° 59′, about S. 22° W. to French Rock, 227 km. distant. Besides these, in the intervening space, and almost in direct alignment, are Macauley Island and Curtis Island.

The present paper is based mainly on a collection of shells made by R. S. Bell at Sunday Island during 1909 and 1910. I have also had at my disposal a portion of the collection made by the expedition to the Kermadecs in 1908; while Mr. T. F. Cheeseman, F.L.S., F.Z.S., Curator of the Auckland Museum, has kindly allowed me to look over the shells from the Kermadec Islands belonging to the institution under his charge.

A number of specimens of Nudibranchs, Aplysioids, *Cerithiidae*, and other small marine shells still remain to be described. Altogether 261 species, including three found only as fossils in the Kermadecs, are enumerated in the present list, made up as follows: Species already recorded (including four described as new in this paper, but hitherto referred to already-described species)—*Amphineura*, 8; *Gastropoda*, 129 (1 fossil); *Lamellibranchia*, 25; *Cephalopoda*, 16. Species already described and now recorded for the first time from the Kermadec Islands—*Gastropoda*, 36 (2 fossil); *Lamellibranchia*, 5. New species—*Gastropoda*, 37; *Lamellibranchia*, 5.

In the preparation of this paper I have received considerable help from Mr. C. Hedley, F.L.S., of Sydney, to whom I showed a portion of my collection when passing through Sydney in October, 1913. For his invaluable aid, freely given, I beg now to tender my sincere thanks. Mr. T. Iredale, M.B.O.U., of London, has also helped in many points by consulting literature and specimens not available to workers in New Zealand. And I have to thank Mr. H. Suter, of Christchurch, for clearing up a number of points which I submitted to him.

I trust the information I intended to give under each species is clearly stated, but to avoid all misunderstanding the following explanation of the plan of the systematic account is given. In the case of already-described species the reference to the original description is given immediately after the name of the species, and for those species already recorded from the Kermadecs the reference to the work where first so recorded is given. Where no such reference is given it signifies that the species is now recorded from the Kermadec Islands for the first time. With new species I have in all cases described in full a single specimen, the type, which in every case has been deposited in the Canterbury Museum, Christchurch. Also, in all cases of new species the type specimen has been figured. "Habitat" is used strictly in the sense in which it is employed by ecologists—namely, as meaning the station

in which an animal lives; but for the sake of uniformity I have also recorded under the same heading the stations in which dead shells were obtained. In all cases, therefore, where information is given under this head (except where noted "Challenger" Expedition) it signifies that I have actually seen specimens from the Kermadecs of the species in question. Under the heading "Distribution" (as distinct from habitat) I give the places where the species has been found. Where this heading is omitted it signifies that the species is, so far as is known, endemic in the Kermadec Islands.

GASTROPODA.

Scutellastra kermadecensis (Pilsbry).

Patella kermadecensis Pilsbry, "Nautilus," vii, 109, 1894.
Recorded, Pilsbry, *l.c.*

Radula.—Formula $31^{21}{}^{2}13$. Rhachidian tooth very small, not nearly reaching to the ends of the laterals. 1st and 2nd laterals, together with the rhachidian, placed anterior to the 3rd lateral and uncini, simple, obtuse; 3rd lateral with 4 cusps, of which the inner one is smallest, the next is largest. Uncini oblique, with 1 cusp.

Shell solid, heavy, broadly oval, narrowed in front. Apex slightly in front of the centre. Slopes straight in all directions. Margin coarsely and irregularly dentate. Height 0·25 to 0·40 of length. *Sculpture:* Shell with raised angular, irregular, radiating ridges, usually only evident at the margin, the greater portion of the upper surface having the ridges obliterated by a covering of shelly matter. Young shell with close irregular high ridges. *Colour:* Upper surface yellowish, but in adult shells the shelly covering usually pale greenish-white. Inner layer porcellaneous white, the muscle-impression often partially or wholly yellow. Margin of interior showing the yellow of the external layer.

Measurements of various shells are here given in tabular form.

Specimen.	Weight.	Length.	Breadth.	Height.	Thickness at Apex.	Ratio Height to Length. (L.=100).
	Grm.	Mm.	Mm.	Mm.	Mm.	
Young		68	54	11	..	16
"		84	71	20	..	24
High	232	122	114	54	9	44
"	193	116	104	56	9	48
Average	208	142	121	48	11	34
"	178	149	126	38	8	26
Heavy	304	142	117	61	14	43
Largest	342	174	160	46	10	26

Habitat.—Abundant living on rocks from just above low-water mark down to 2 m. or 3 m., Sunday Island. The largest specimens have been taken in less than 2 m. of water at low tide. This species lives on the upper surface of the rocks, and the shells are almost invariably covered with coralline and other algae, together with *Siphonaria*, *Elminius*, and young examples of their own species, all likewise covered with algae. Also found on Macauley Island, Curtis Island, and French Rock.

Fossil.—Small shells occur in fragments of volcanic tuff found on the south-east coast of Sunday Island.

Cellana H. Adams.

Extremely abundant on rocks between tide-marks throughout the Kermadec Islands, the members of this genus constitute a highly variable and puzzling array of forms, diverging into four distinct types, which I have ranked as species. But though typical examples of these four species cannot be confused, and are distinguished by characters of form and sculpture which undoubtedly would be counted as of good specific value in any genus, yet intermediate forms appear so frequently and of such non-characteristic features, and any form merges by so complete a series into each of the others, that it is impossible exactly to define the limits of the species here accepted. But the differences between the extreme forms are so great that it is inconceivable that any one could produce any of the others; consequently I have no hesitation in ranking them as species, notwithstanding the multitude of intermediate variations. Especially bewildering to the despairing systematist are young shells, where nondescript forms inseparable into well-defined groups gradually pass into all four species. This is a suggestive and perhaps significant fact, for it may be that there are four or more species now in course of production in the Kermadec Group, and the form with the least distinctive characters—that which agrees with the type of *C. craticulatus*—possibly approaches most closely to the supposed ancestor. A relationship between variation on the one hand and habitat and distribution on the other is also indicated, for, although all the forms were found on Sunday Island, two only *C. craticulatus prolixus* and *C. hedleyi*—were there dominant, and these showed a tendency to group themselves in distinct belts, *prolixus* usually occurring higher up on the rocks than *hedleyi*. *C. vulcanicus* was chiefly found on the outlying Meyer Island; *C. hedleyi corrugata* was the only form found on Macauley Island; while *C. scopulinus* alone was collected on French Rock.

To sum up, the examination of ample material leads me to the conclusion that in the Kermadec Group there exist about four species of *Cellana* in process of being formed out of a single species, and the young of all are frequently so much alike that a satisfactory disposition is scarcely possible. I can suggest no explanation of any value as to the cause of this great variability. An inherent tendency to vary which must be postulated for all organisms apparently has had full scope for the production of variants, while, perhaps through the non-arrival of other competitors in the area, selection has not acted on the variable characters. *Cellana* is not the only genus in which apparent unlimited variability has taken place in the Kermadec Islands. The case of *Pterodroma neglecta* is perhaps one of the most remarkable among birds. In this species every variation of colour between a uniformly black bird and one all white except the wings and back may be seen during the breeding season at Sunday Island.

Cellana craticulatus (Suter).

Helcioniscus craticulatus Suter, Pro. Mal. Soc., vi, 352, 1905.

Recorded, Suter, *l.c.*

Shell depressed, height 0·24 to 0·32 of length, broadly elliptical, narrowed in front. Apex about one-third the length from the anterior end. Anterior slope nearly straight, posterior slope arched. Margin finely crenulate. *Sculpture:* Exterior with numerous (about 70) close, radiating, small, slightly irregular riblets, made slightly uneven or minutely beaded by concentric growth-lines. *Colour:* Above dark green, variously marked with

blotches of grey or radiating stripes of yellowish. Interior iridescent slaty blue, spatula brown with white centre. Dark colour-markings (seen on holding shell to light) in narrow radiating streaks; sometimes broader bands are faintly indicated.

Length,	25·2 mm.	Breadth,	21·4 mm.	Height,	7·0 mm.
,,	24·2 mm.	,,	20·2 mm.	,,	5·8 mm.
,,	27·8 mm.	,,	22·7 mm.	,,	8·8 mm.

This is a most variable species, to which I assign a multitude of depressed shells which I cannot satisfactorily place under any other species. I would venture to say that its variants afford ample material for the production of all the species of *Cellana* in the Kermadecs.

Habitat.—Abundant living on rocks between tide-marks, Sunday Island; most frequent about half-tide mark.

Subsp. **prolixus** n. subsp. Figs. 1 and 1*a*.

Description of Type Specimen.—*Shell* depressed, height 0·29 of length, broadly elliptical, slightly narrowed in front. Apex at the anterior fourth. Anterior slope very slightly concave; posterior slope convex above, the lower half straight. Margin crenulate. *Sculpture:* The apical portion is corroded and sharply marked off from the remainder of the shell, which is ornamented by numerous (over 100) fine radiating riblets. These are slightly irregular in size, tending to groups of threes, the central one of which is slightly larger than the others. All are crossed by concentric growth-lines, giving a fine beaded appearance. *Colour:* The apical portion greyish-white with a row of brown spots at the margin. Basal portion pale lemon-yellow, darker above, with numerous radiating narrow brown lines. Interior iridescent lemon-yellow with radiating brown lines, spatula brown with a white centre.

Length, 32 mm. Breadth, 28·2 mm. Height, 9·2 mm.

Variations from Type.—In its typical state this variety is very distinct. On the ground-colour and interior becoming darker it passes over into the typical form. The apex may be quite or not at all corroded. A corroded apex surrounded by a whitish ring showing radiating brown bands is a characteristic feature of this subspecies, and appears frequently in young shells.

Length,	31·4 mm.	Breadth,	26·4 mm.	Height,	7·4 mm.
,,	27·0 mm.	,,	22·5 mm.	,,	7·2 mm.
,,	21·5 mm.	,,	18·0 mm.	,,	5·8 mm.

This subspecies I at first supposed to be the true *craticulatus*, and Iredale also (Pro. Mal. Soc., ix, 72) has confused both this form and *C. scopulinus* with the type of *craticulatus*. By submitting specimens to Mr. Suter I finally had the matter cleared up.

Habitat.—Abundant living on rocks between tide-marks, Sunday Island.

Cellana hedleyi n. sp. Figs. 2 and 2*a*.

Description of Type Specimen.—*Shell* depressed, height 0·24 of length, oval, narrowed in front. Apex about one-fourth the length from the anterior end. Anterior slope nearly straight, posterior slope convex. Margin irregularly crenulate. *Sculpture:* There are 22 broad leading ridges, each with 3 to 5 ribs nearly equal in size and regularly beaded. *Colour:* Above dark yellowish-green with 9 dark brownish-green bands on alternate leading ridges, 4 being directed forwards and 5 backwards from

the apex, thus leaving 3 leading ridges on each side of the apex dark yellowish-green. In addition to the broad bands, there are in the interstices between the ribs numerous narrow reddish-brown streaks leading from the margin towards the apex (seen on holding shell to light in both light and dark areas). Interior iridescent slaty blue, spatula brown.

Length, 42·5 mm. Breadth, 34·8 mm. Height, 10·3 mm.

Variations from Type.—The ridges vary somewhat in height and regularity, and specimens in which they are almost obsolete approach those of *C. craticulatus prolixus* and *C. vulcanicus*. The normal number is apparently 22, though usually more can be counted. The colour-pattern dividing the shell into 22 areas is characteristic of this species. Some New Zealand species exhibit similar pattern. A perfectly regular specimen of *C. hedleyi* shows the central anterior ridge light-coloured, the central posterior ridge dark-coloured. On each side between these the order from the anterior end is dark, light, dark, 3 light, dark, light, dark, light—thus making 22 in all. In old specimens the external surface of the shell is usually corroded and more or less whitish in colour; the anterior, too, is whitish, with the margin clearly showing the ends of the numerous dark streaks.

Length,	45·8 mm.	Breadth,	37·5 mm.	Height,	14·2 mm.
„	37·5 mm.	„	28·7 mm.	„	9·3 mm.
„	27·5 mm.	„	21·6 mm.	„	5·7 mm.

Habitat.—Living on rocks between tide-marks, Sunday Island. This is the most common limpet on Sunday Island, and occurs generally just above low-tide mark.

Subsp. **corrugata** n. subsp. Figs. 3 and 3*a*.

Description of Type Specimen.—*Shell* moderately high, height 0·32 of length, oval, narrowed and truncated in front. Apex in the anterior third. Anterior and posterior slopes convex. Margin irregularly dentate. *Sculpture:* There are about 27 high angular ridges of varying heights, each bearing 2 to 5 beaded ribs. A beaded rib often in the interstices. *Colour:* Above dark yellowish-green, becoming paler towards the centre. Interior iridescent slaty blue, central portion white. Dark colour-streaks (one in nearly every interstice seen on holding shell to light) reddish-brown, narrow, mostly continuous from near apex to margin.

Length, 38 mm. Breadth, 32·3 mm. Height, 12 mm.

Variations from Type.—Measurements:—

Length,	42·8 mm.	Breadth,	37·0 mm.	Height,	11·3 mm.
„	47·8 mm.	„	42·0 mm.	„	17·0 mm.
„	38·8 mm.	„	31·6 mm.	„	15·8 mm.

Habitat.—Common living on rocks between tide-marks, Macauley Island, and the only *Cellana* collected there. I have also one specimen from Sunday Island.

Cellana vulcanicus n. sp. Figs. 4 and 4*a*.

Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Helcioniscus dirus*).

Description of Type Specimen.—*Shell* high, height 0·42 of length, elliptical, slightly narrowed in front. Apex more than a third of the length from the anterior end. Anterior slope steep, nearly straight; posterior slightly convex. Margin finely crenulate. *Sculpture:* There are about 60 well-marked radiating ribs, alternately high and low, crossed by concentric growth-lines, giving a beaded appearance, The apex is corroded. *Colour:*

Above light yellowish-green. Interior iridescent pearly, the muscle-impression bluish and the spatula brown with a white centre. The margin is marked by numerous short reddish-brown streaks.

Length, 30·2 mm. Breadth, 25 mm. Height, 12·8 mm.

Variations from Type.—The young are prominently ribbed, dark green above and slaty blue within. Old shells are often much corroded, especially above the apex, and are of a pale pearly or whitish appearance within.

Length, 35·2 mm.	Breadth, 28·0 mm.	Height, 16·3 mm.
,, 32·3 mm.	,, 26·8 mm.	,, 17·8 mm.
,, 27·3 mm.	,, 22·3 mm.	,, 12·8 mm.

A very distinct species, which Iredale referred to *H. dirus* Reeve. In a later communication to me, however, he admits that it differs slightly from that species. As Reeve's species is founded on specimens of unknown locality, and apparently related to a North Atlantic form, I think the proper course is to describe the Kermadec shell as new. The species of *Cellana* are often very restricted in their distribution.

Habitat.—Living on rocks between tide-marks, Meyer Islet. Also collected on Sunday Island.

Cellana scopulinus n. sp. Figs. 5 and 5*a*.

Recorded, Suter, Man. N.Z. Moll., 79, 1913 (*Helcioniscus antipodum*).

Description of Type Specimen.—*Shell* high, height 0·38 of length, elliptical. Apex acute, in the anterior third. Anterior slope straight, posterior arched. Margin finely crenulate. *Sculpture:* The whole upper surface with close regular radiating ribs crossed by concentric growth-lines, giving a faintly beaded appearance. The ribs not quite equal in size, every third one being slightly larger than the intervening two. *Colour:* Above yellow, darkening towards the apex. Interior bright orange-yellow, paler at the margin and on the muscle-impression, spatula rich brown with white centre. No dark colour-markings.

Length, 35 mm. Breadth, 29·4 mm. Height, 13·4 mm.

Variations from Type.—Large old specimens show the whole outer surface corroded, and sometimes bearing algae and *Elminius;* interior more or less whitish, except the margin, which is yellow, and may show numerous short reddish-brown streaks. Some young specimens show radiating dark colour-streaks. All specimens seen from Sunday Island were young, with radiating dark colour-streaks.

Measurements, French Rock specimens:—

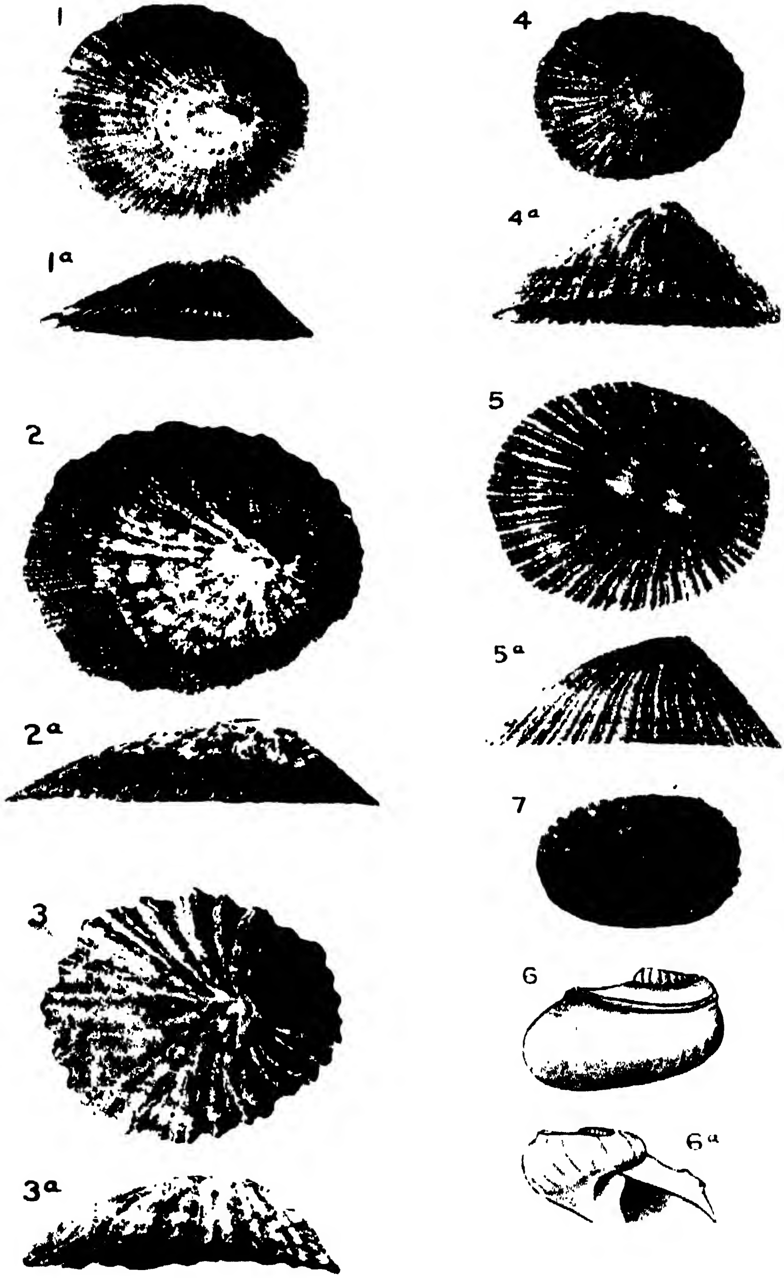
Length, 50·0 mm.	Breadth, 42·0 mm.	Height, 20·8 mm.
,, 50·6 mm.	,, 42·7 mm.	,, 24·2 mm.

Suter records this species from the Kermadecs as *Helcioniscus antipodum*, but, though young specimens resemble that species somewhat, full-grown examples cannot be confused. Compared with *C. scopulinus*, *C. antipodum* has larger ribs, and the colour-pattern, including about 11 wide dark bands, is quite different. *C. trameroserica* of Australia is apparently identical with Suter's *H. antipodum* of New Zealand.

Habitat.—Common living on rocks between tide-marks, French Rock, and the only species of *Cellana* collected there. Sunday Island; not common.

Schismope pacificus n. sp. Figs. 6 and 6*a*.

Description of Type Specimen. — *Shell* turbinate, keeled, umbilicate. Spire flattened. Whorls 3, the last rapidly descending. Body-whorl



Kermadec Island Mollusca.

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strongly keeled midway between the periphery and the suture, the keel double, enclosing the anal perforation, and becoming obsolete near the outer lip. Anal perforation long and narrow, rounded behind, pointed in front. Aperture pyriform, semi-detached. Outer lip at its posterior attachment sharply reflected and spread over the body-whorl till it joins with the inner lip. Umbilicus large, deep. *Sculpture:* There are regular transverse ribs on the apical whorls and part of the periphery of the body-whorl, while the whole shell is crossed by fine spiral striae and faint transverse growth-lines. *Colour* white.

Diameter, 1 mm.

Variations from Type. The aperture is sometimes quite detached, and the transverse ribs are more prominent in some specimens than in others, while the keel may extend well up the spire.

Habitat.—Dead shells dredged on gravelly bottom in 10 m. to 30 m. near Sunday Island.

Fissuridea bollonsi n. sp. Fig. 7.

Description of Type Specimen.—*Shell* moderately elevated, height 0·41 of length, elongate-elliptical. Apex in anterior third. Anterior slope straight, posterior slightly convex. Margin crenulate. Foramen elongate, the sides parallel at each end, but bowed outwards in the middle third. *Sculpture:* About 40 beaded ribs alternating with an equal number of much smaller beaded riblets. Under the microscope the beads appear as prominent blunt points. *Colour:* Above dirty white, interior white, showing about 10 faint dark bands.

Length, 9·2 mm. Breadth, 6 mm. Height, 3·8 mm.

Variation from Type.—There is some variation in the proportions of the shells, indicated by the following measurements. A few are depressed and elongate-elliptical; a few high, broadly elliptical, with the anterior slope concave and the posterior slope much arched. These latter are old shells, which, from growing normally at first, slightly alter the direction of their sides. Sometimes a distinct horizontal suture is present, as though there had been a resting between two growing periods. Foramen in young specimens well in front of the apex; in adult shells it is at the apex. In many individuals the colour-bands are absent.

Length,	11·0 mm.	Breadth,	7·8 mm.	Height,	4·0 mm.
,,	10·7 mm.	,,	6·6 mm.	,,	3·5 mm.
,,	10·2 mm.	,,	7·2 mm.	,,	6·0 mm.

Habitat.—Living on rocks under a coral-like alga, South Bay, Sunday Island; plentiful.

Tectus royanus (Iredale).

Trochus royanus Iredale, Pro. Mal. Soc., x, 225, 1912.

Recorded, Iredale, *l.c.*

Sculpture: In adult shells the upper surface is invariably covered with algae, coralline and other, while the base usually supports a colony of *Serpulae.* Young shells, however, show the sculpture. Suture well marked. The whorls are flat, with very low rounded nodules along the lower edge, there being about 15 at a distance of 2 cm. from the apex, but sometimes they are so indistinct that they can scarcely be detected. The whole exterior is ornamented by close spiral beaded ribs, about 10 to a centimetre, crossed by diagonal growth-lines, and covered with a white calcareous coating. The base has diagonal growth-lines on a white calcareous covering,

but near the interior, where the coating is absent, it shows regular spiral threads, which are closest along the exterior margin. *Colour* white, interior pearly iridescent, with a well-marked white margin on the exterior of the outer lip.

Height, 77 mm. Major diameter, 84 mm.
„ 80 mm. „ 97 mm.

A very distinct species, the occurrence of which in the Kermadecs is as remarkable as that of *Scutellastra kermadecensis*, *Cassidea royana*, and *Spondylus raoulensis*. *Tectus royanus* is allied to *T. pyramus* Born, an Indo-Pacific species, but differs in colour and in sculpture, which is much finer than that in *T. pyramus*.

Habitat.—Sunday Island and Meyer Islet. Living on rocks from low-water mark down to 6 m. or 8 m.; fairly plentiful in places, but difficult to collect. One or two live specimens were taken between tide-marks.

Fossil.—A broken shell was extracted from a block of lava lying on the shore on the east side of Sunday Island. The rock was identified as being part of a lava-flow about 50 m. higher up the cliff. (*Trochus* sp. Oliver, Trans. N.Z. Inst., 43, 531.)

Trochus calcaratus Souverbie.

Trochus calcaratus Souverbie, Journ. de Conch., 1875, 41, t. 4, fig. 7.

Fossil.—Fragments taken from hard sandy tuffs of submarine origin on Dayrell Islet, off Sunday Island, agree, so far as they go, with this species. (*Trochus* sp. Oliver, Trans. N.Z. Inst., 43, 527.)

Distribution (Recent).—Lord Howe Island, Australia, New Caledonia, Philippines.

Clanculus atypicus Iredale.

Clanculus atypicus Iredale, Pro. Mal. Soc., x, 225, 1912.
Recorded, Iredale, *l.c.*

Habitat.—Living under stones near low-water mark, Coral Bay, Sunday Island. On stones in rock-pools, Meyer Island.

Clanculus stigmatarius A. Adams.

Clanculus stigmatarius A. Adams, Pro. Zool. Soc., 1851, 161, 1852.

Fossil.—One shell taken from hard sandy tuffs of submarine origin on Dayrell Islet, near Sunday Island. Specimen not quite typical. (*Clanculus* sp. Oliver, Trans. N.Z. Inst., 43, 527.)

Distribution (Recent).—Australia, New Caledonia, Western Pacific, Philippines.

Solariella incerta (Iredale).

Monilea incerta Iredale, Pro. Mal. Soc., x, 226, 1912.
Recorded, Iredale, *l.c.*

Habitat.—Living among rocks between tide-marks, Sunday Island.

Gena oliveri Iredale.

Gena oliveri Iredale, Pro. Mal. Soc., x, 226, 1912.
Recorded, Iredale, *l.c.*

Habitat.—Living among rocks near low-water mark, Sunday Island.

Very closely allied to a species in Norfolk Island, which differs principally in having fine close spiral striae.

Angaria tyria (Reeve).

Delphinula tyria Reeve, Pro. Zool. Soc., 1842, 102, 1843.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Living among rocks near low-water mark, Meyer Island; not common.

Distribution.—Australia.

Angaria distorta (Linné).

Turbo distorta Linné, Syst. Nat., ed. x, p. 764, 1758.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—One shell found on beach, Sunday Island (Iredale).

Distribution.—Indian Ocean.

Philorene gen. nov.

Shell subdiscoidal, the body-whorl descending, umbilicate; spire depressed; whorls rounded; aperture circular; peristome continuous.

Type.—*P. texturata* Oliver.

Philorene texturata n. sp. Fig. 8.

Description of Type Specimen.—*Shell* subdiscoidal, the body-whorl slightly descending, umbilicate, whorls 3. Spire flat, body-whorl circular in section, its upper portion level with the periphery of the penultimate whorl. Aperture circular, peristome continuous, slightly expanded above and below on the inner side. Umbilicus deep. Suture deep. *Sculpture:* Protoconch smooth. Regular transverse ridges on the base of the whorls round the umbilicus. Interior of umbilicus with spiral ridges terminating at the lower expansion of the inner lip. Over the whole surface of the shell are close regular low spiral threads ornamented with transverse lenticular beads. *Colour* white.

Maximum diameter, 2 mm.; minimum diameter, 1·5 mm.

Habitat.—Dead shells common in dredgings near Sunday Island.

Brookula stibarochila Iredale.

Brookula stibarochila Iredale, Pro. Mal. Soc., x, 220, 1912.
Recorded, Iredale, *l.c.*

Specimens vary considerably in the number of ribs; the type has them wide apart.

Habitat.—A few dead shells dredged near Sunday Island.

Turbo argyrostomus Linné.

Turbo argyrostomus Linné, Syst. Nat., ed. x, 764, 1758.
Recorded (fossil), Oliver, Trans. N.Z. Inst., 43, 527, 1911.

Fossil.—Plentiful in hard sandy tuffs of submarine origin on Dayrell Islet, off Sunday Island.

Distribution (Recent).—Australia, Pacific Ocean from New Caledonia to Hawaii and the Paumotus, Indian Ocean.

Leptothyra picta (Pease).

Collonia picta Pease, Amer. Journ. Conch., iv, 91, 1868.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells abundant in dredgings on gravelly bottom near Sunday Island, in 10 m. to 30 m.

Distribution.—Society Islands, Paumotus.

Nerita melanotragus E. A. Smith.

Nerita melanotragus E. A. Smith, Zool. Col. H.M.S. "Alert" (1, viii), 69, 1884.
Recorded, E. A. Smith, *l.c.*

Habitat.—Abundant living on rocks between tide-marks, most frequent at half-tide mark or higher, Sunday Island, Macauley Island.

Fossil.—In fragments of volcanic tuffs at Titi Knob, on east coast of Sunday Island.

Distribution.—Lord Howe Island, Norfolk Island, New Zealand, Tasmania, Australia, Henderson Island (East Pacific).

Nerita plicata Linné.

Nerita plicata Linné, Syst. Nat., ed. x, 779, 1758.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Living on rocks about half-tide mark, Sunday Island and Meyer Island; very rare.

Distribution.—Lord Howe Island, Norfolk Island, Australia, Pacific Ocean from New Caledonia to Hawaii, Indian Ocean.

Pronesopupa senex Iredale.

Pronesopupa senex Iredale, Pro. Mal. Soc., x, 385, 1913.
Recorded, Iredale, *l.c.*

Habitat.—Living on tree-trunks not moss-covered on the low ground, chiefly on *Corynocarpus* and *Melicytus* trees, Sunday Island.

Melarhaphe unifasciata (Gray).

Litorina unifasciata Gray, King's "Survey of Australia," ii, App., 483, 1826.

Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Littorina mauritiana*).

Habitat.—Living on rocks near high-water mark, north coast, Sunday Island; rare.

Distribution.—Lord Howe Island, New Zealand, Tasmania, Australia.

Tectarius feejeensis (Reeve).

Littorina feejeensis Reeve, Conch. Icon., fig. 82, 1857.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Living on rocks near high-water mark, north coast, Sunday Island.

Distribution.—Indian and Pacific Oceans.

Hinea brasilianus (Lamarck).

Buccinum brasilianus Lam., Anim. s. Vert., vii, 272, 1822.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Planaxis*).

Habitat.—Abundant living on rocks between tide-marks, Sunday Island.

Distribution.—Lord Howe Island, Norfolk Island, New Zealand, Australia, Easter Island.

Haurakia kermadecensis n. sp. Fig. 9.

Description of Type Specimen.—*Shell* ovate, apex blunt, aperture broadly ovate. Whorls 5, rounded, suture impressed. Inner lip slightly detached,

giving a small umbilical depression. *Sculpture:* Protoconch of 1½ whorls spirally ribbed, there being 4 spirals on the lower whorl. First adult whorl with pronounced longitudinal plications, crossed by 3 spirals, 2 near the upper and 1 near the lower suture, and slightly beaded at the intersections. In the succeeding whorls the three spirals are more pronounced and the central space is faintly spirally ribbed, the axial plications remaining fairly prominent. In the body-whorl the longitudinals become obsolete at the periphery, while there are about 12 spiral ribs, the upper one most prominent, the 4th and 5th least so. *Colour:* White with spiral brown lines; the protoconch ribs are brown, also the two upper and one lower spiral ribs on the succeeding whorls, and 1st to 3rd and 6th to 10th spirals on the body-whorl, leaving the peripheral two white.

Height, 1·8 mm. Diameter, 1 mm.

Habitat.—Dead shells dredged abundantly in 10 m. to 30 m. on gravelly bottom off Sunday Island.

Notosetia electra n. sp. Fig. 10.

Description of Type Specimen.—*Shell* minute, ovate, apex obtuse. Whorls 3½, flattened, suture distinct. Aperture circular, peristome thin, not continuous. A small umbilical depression between the inner lip and the body-whorl. *Sculpture:* Protoconch smooth. Shell with microscopic spiral striae indicated. *Colour* pink.

Height, 0·7 mm. Diameter, 0·4 mm.

Habitat.—A few dead shells dredged on gravelly bottom near Sunday Island.

Merelina pisinna (Melvill and Standen).

Alvania pisinna Melv. & Stand., Journ. Conch., viii, 305, 1896.

Habitat.—Dead shells dredged abundantly in 10 m. to 30 m. on gravelly bottom near Sunday Island.

Distribution.—Loyalty Islands.

Onoba carnosa (Webster).

Rissoia carnosa Webster, Trans. N.Z. Inst., 37, 278, 1905.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Rissoa*).

This species occurs in four fairly well-defined colour-varieties, which may be characterized as under:—

1. Var. *typica.*—Spirally marked brown and white; the lower half of each whorl brown, the upper half white.
2. Var. *fusca.*—The whole shell brown.
3. Var. *alba.*—The whole shell white.
4. Var. *bicolor.*—Spire brown, body-whorl white.

Habitat.—Dead shells abundant in dredgings on gravelly bottom in 10 m. to 30 m. near Sunday Island.

Distribution.—New Zealand (varieties *typica, fusca,* and *bicolor*).

Onoba candidissima Webster.

Rissoia candidissima Webster, Trans. N.Z. Inst., 37, 278, 1905.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Rissoa*).

Habitat.—Dead shells dredged on gravelly bottom in 10 m. to 30 m. near Sunday Island.

Distribution.—New Zealand.

Rissoina angasi Pease.

Rissoina angasi Pease, Amer. Journ. Conch., vii, 20, 1872.

Habitat.—Living under stones near low-water mark, Coral Bay, Sunday Island.

Distribution.—New South Wales.

Rissoina plicata A. Adams.

Rissoina plicata A. Adams, Pro. Zool. Soc., 1851, 264, 1852.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells dredged on gravelly bottom near Sunday Island.

Distribution.—New Guinea, Fiji, Ellice Group, Hawaii.

Zebina cooperi n. sp. Fig. 11.

Description of Type Specimen.—*Shell* elongate-ovate, the right side straight, the left slightly convex. Aperture ovate, slightly produced laterally. Whorls 7, flattened, the suture scarcely marked. Outer lip very thick, with 3 blunt tubercles inside the anterior end. A distinct canal between the posterior end and the body-whorl. *Sculpture:* Protoconch smooth. First adult whorl with about 12 longitudinal plications. The distance between them increases while their height decreases, until they become quite obsolete on the 4th whorl. On the parietal wall, near the posterior canal, are 3 minute longitudinal plications. Otherwise the shell is perfectly smooth and glassy, with microscopic axial striations. *Colour:* Glassy white, the interior structure indicated by darker spiral bands.

Height, 5 mm. Diameter, 2·4 mm.

Habitat.—Dead shells abundant in dredgings on gravelly bottom in 10 m. to 30 m. near Sunday Island.

Isselia chiltoni n. sp. Fig. 12.

Description of Type Specimen.—*Shell* elongate-ovate, the aperture slightly extended laterally. Whorls 5½, slightly flattened, suture deep. Aperture ovate, notched in front. Columella obliquely truncated anteriorly. Inner lip thickened, forming a callosity at the anterior angle of the columella. *Sculpture:* Protoconch of 1 whorl, smooth. First adult whorl with about 10 longitudinal plications. On the following whorl the longitudinal plications are crossed by 3 spiral ribs, the lowest only being prominent, beaded at the intersections. On the penultimate whorl a 4th spiral is added. On the body-whorl above are 9 spiral ribs, forming nodules at the intersections of longitudinal plications; the 2nd and 3rd spirals approximate, as do the 4th and 5th. On the under-surface these appear as 6 ribs, the upper being double. The interstices between the four anterior spirals about twice the width of the ribs. *Colour* white.

Height, 2·8 mm. Diameter, 1·4 mm.

Habitat.—Dead shells abundant in dredgings in 10 m. to 30 m. off Sunday Island.

Epigrus insularis n. sp. Fig. 13.

Description of Type Specimen.—*Shell* elongate, apex blunt, aperture produced, the body-whorl more than half the length of the shell. Whorls 4½, loosely coiled, rounded, shouldered above, suture deeply impressed. Aperture oval, peristome continuous, thickened throughout, a distinct

groove separating the inner lip from the body-whorl. *Sculpture:* Protoconch smooth, shining. Shell smooth, faintly microscopically marked spirally, also transversely, with growth-lines. *Colour* white.

Height, 2·8 mm. Diameter, 1 mm.

Habitat.—Dead shells dredged on gravelly bottom in 10 m. to 30 m. near Sunday Island.

Epigrus gracilis n. sp. Fig. 14.

Description of Type Specimen.—*Shell* elongate, slender, the whorls increasing but little in size. Whorls 4½, flattened, loosely coiled, margined above, suture deeply impressed. Aperture oval, peristone continuous, thin, inner lip separated from body-whorl by a distinct groove. *Sculpture:* Protoconch smooth. Shell with spiral threads and lines. On 1st adult whorl about 5 narrow low threads, which broaden and increase on succeeding whorls, there being on the body-whorl about 6 principal and as many smaller spiral threads, the interstices having under a high power a rough pitted appearance. *Colour* white.

Height, 1·7 mm. Diameter, 0·5 mm.

Habitat.—Dead shells dredged on gravelly bottom in 10 m. to 30 m. off Sunday Island.

Cerostraca n. gen.

Shell ovate, thin, whorls rounded, suture impressed. Aperture detached, circular, body-whorl anteriorly having a callosity just above the produced and expanded outer lip.

Type.—*C. iredalei* Oliver.

Cerostraca iredalei n. sp. Fig. 15.

Description of Type Specimen.—*Shell* ovate, apex blunt, the body-whorl bearing in front a prominent transverse callosity. Aperture completely detached from body-whorl, circular, the margin thin and expanded. *Sculpture:* Shell quite smooth. *Colour:* Protoconch white. Adult whorls glassy pink, a dark-pink spiral line below the suture, and another on the base of the whorl-shell. Anterior callosity dark pink. Peristome white.

Height, 1·3 mm. Diameter, 0·7 mm.

Habitat.—Dead shells dredged on gravelly bottom in 10 m. to 30 m. off Sunday Island.

Amphithalamus sundayensis n. sp. Fig. 16.

Description of Type Specimen.—*Shell* minute, ovate, apex blunt. Whorls 4, flattened, suture impressed. Aperture detached, broadly elliptical, slightly angled behind. Peristome thickened, a ridge connecting its posterior end with the body-whorl. Umbilical furrow wide. *Sculpture:* The whole shell quite smooth. *Colour:* Light olive-brown, the suture, peristome, and lower part of body-whorl darker.

Height, 1·2 mm. Diameter, 0·6 mm.

Habitat.—Dead shells dredged on gravelly bottom in 10 m. to 30 m. near Sunday Island.

Heterorissoa secunda Iredale.

Heterorissoa secunda Iredale, Pro. Mal. Soc., x, 222, 1912.

Recorded, Iredale, *l.c.*

Habitat.—Dead shells common in dredgings in 10 m. to 30 m. off Sunday Island.

Assiminea nitida (Pease).

Hydrocena nitida Pease, Pro. Zool. Soc., 1864, 674, 1865.
Recorded, Iredale, Pro. Mal. Soc., x, 370, 1913 (*Barleeia chrysomela*).

Habitat.—Living on rocks wetted by fresh water near the coast, Sunday Island and Dayrell Islet. (Dead shells occasionally dredged off the shore.)
Distribution.—Lord Howe Island, Norfolk Island, New Caledonia, Polynesia.

Royella sinon (Bayle).

Cerithium sinon Bayle, Journ. de Conch., xxviii, 243, 1880.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Cerithiopsis*).

Habitat.—Dead shells found on the beaches, Sunday Island.
Distribution.—Norfolk Island, Lifu, Bohol, Henderson Island (East Pacific).

Cerithium bavayi Vignal.

Cerithium bavayi Vignal, Journ. Conch., xlix, 304, 1901.

Habitat.—A few dead shells washed up on the beaches, Sunday Island.
Distribution.—Loyalty Islands.

Joculator pinea (Hedley).

Cerithiopsis pinea Hedley, Pro. Linn. Soc. N.S.W., 34, 440, 1909.

Habitat.—A few dead shells dredged off Sunday Island on gravelly bottom in 10 m. to 30 m.
Distribution.—Queensland.

Joculator aelomitres (Melvill and Standen).

Bittium aelomitres Melvill and Standen, Journ. Conch., viii, 298, 1896.

Habitat.—Dead shells dredged in 10 m. to 30 m. off Sunday Island.
Distribution.—Lifu.

Sundaya n. gen.

Shell pupoid, apex obtuse, sides convex. Protoconch minute, of 1 whorl. Body-whorl contracting anteriorly, canal nearly straight, sculptured with nodulous spiral ribs.
Type.—*S. exquisita* Oliver.

Sundaya exquisita n. sp. Fig. 17.

Description of Type Specimen.—*Shell* pupoid, apex obtuse, body-whorl more than half the length of the shell. Whorls 4, flattened, suture impressed. Aperture rhomboid, angled behind, notched in front. Canal short. Outer lip thin, slightly expanded. *Sculpture:* Protoconch smooth. First adult whorl with 2, remainder with 3, spiral nodulous ribs. The nodules arranged regularly in longitudinal as well as spiral rows, about 15 longitudinal rows on the body-whorl. Base with 3 spiral ridges not nodulous. *Colour:* Reddish-brown, the protoconch and lip lighter.
Height, 1 mm. Diameter, 0·5 mm.
Habitat.—A few dead shells dredged in 10 m. to 30 m. on gravelly bottom near Sunday Island.

Triphora granifera Brazier.

Triforis granifera Brazier, Pro. Linn. Soc. N.S.W., ix, 173, 1894.

Habitat.—Dead shells dredged on gravelly bottom in 10 m. to 30 m. off Sunday Island.
Distribution.—New South Wales.

Triphora jousseaumei Hervier.

Triforis jousseaumei Hervier, Journ. de Conch., 45, 250, 1898.

Habitat.—Dead shells dredged on gravelly bottom in 10 m. to 30 m. near Sunday Island.
Distribution.—Lifu.

Triphora ampulla Hedley.

Triphora ampulla Hedley, Pro. Linn. Soc. N.S.W., 27, 615, 1903.

Habitat.—Dead shells dredged on gravelly bottom in 10 m. to 30 m. off Sunday Island.
Distribution.—New Zealand, New South Wales.

Sinistroseila n. gen.

Shell turreted, sinistral, sculptured with spiral ridges only.
Type.—*Triforis incisus* Pease.

Sinistroseila incisus (Pease).

Triforis incisus Pease, Pro. Zool. Soc., 1860, 434, 1861.

Habitat.—A few dead shells dredged in 10 m. to 30 m. on gravelly bottom off Sunday Island.
Distribution.—Hawaii, Funafuti, New Guinea.

Caecum solitarium n. sp. Fig. 18.

Description of Type Specimen.—*Shell* curved, of nearly uniform diameter throughout, anteriorly obliquely truncate. Septum much exserted, hemispherical, making an abrupt shoulder at the junction of the shell. *Sculpture:* Shell smooth, but showing under the microscope regular concentric growth-lines. *Colour* white.

Length, 2·7 mm. Diameter at anterior end, 0·4 mm.; at posterior end, 0·3 mm.

Habitat.—A few dead shells dredged near Sunday Island.

Alata aratrum Martyn.

Alata aratrum Martyn, Univ. Conch., i, 50, 1784.
Recorded, Iredale, Pro. Mal Soc., ix, 71, 1910 (*Strombus*).

Habitat.—Dead shells found on the beaches, Sunday Island.
Distribution.—Indo-Pacific region.

Strombus urceus Linné.

Strombus urceus Linné, Syst. Nat., ed. x, 745, 1758.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.
Distribution.—Lord Howe Island, Norfolk Island, Australia, Philippines, Indian Ocean.

Strombus elegans Sowerby.

Strombus elegans Sowb., Thes. Conch., t. 7, figs. 43, 48.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—One dead shell dredged (Iredale).
Distribution.—Australia, Indo-Pacific.

Xenophora corrugata (Reeve).

Phorus corrugata Reeve, Pro. Zool. Soc., 1842, 163, 1843.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dredged alive in 30 m. near Meyer Island (W. S. Bell).
Distribution.—New Zealand, Indian Ocean, Japan.

Roya nutatus (Hedley).

Capulus nutatus Hedley, Pro. Linn. Soc. N.S.W., 33, 467, 1908.
Recorded, Iredale, Pro. Mal. Soc., x, 218, 1912 (*R. kermadecensis*).

Habitat.—Taken alive at Sunday Island by R. S. Bell.
Distribution.—New South Wales.

Hipponix foliacea Quoy and Gaimard.

Hipponix foliacea Q. & G., Voy. "Astrolabe," Zool., iii, 439, 1834.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Living on stones in rock-pools at Meyer Island; fairly common.
Fossil.—In hard sandy volcanic tuffs of submarine origin at Dayrell Islet. (*Amalthea* sp. Oliver, Trans. N.Z. Inst., 43, 527.)
Distribution.—Indo-Pacific region.

Natica sagittata Menke.

Natica sagittata Menke, Moll. Nov. Holl., 10, 1843.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—A few dead shells washed up on the beaches, Sunday Island.
Distribution.—Lord Howe Island, Norfolk Island, Australia.

Natica orientalis Gmelin.

Natica orientalis Gmelin, Syst. Nat., ed. xiii, 3673, 1791.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells rarely washed up on beaches, Sunday Island.
Distribution.—Lord Howe Island, Malay Archipelago.

Polinices simiae (Deshayes).

Natica simiae Deshayes, Anim. s. Vert., viii, 522.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells frequently washed up on the beaches, Sunday Island.
Distribution.—Lord Howe Island, Norfolk Island, Philippines, Pacific Ocean.

Lamellaria ophione Gray.

Lamellaria ophione Gray, Pro. Zool. Soc., 1849, 169, 1850.
Recorded, Suter, Subantarctic Is. N.Z., i, 22, 1909.

Habitat.—Dead shells rarely found washed up on the beaches, Sunday Island.
Distribution.—New Zealand, Tasmania, Australia.

Vanikoro wallacei Iredale.

Vanikoro wallacei Iredale, Pro. Mal. Soc., x, 226, 1912.
Recorded, Iredale, *l.c.*

Habitat.—Living under stones in rock-pools, Meyer Island.

Ianthina violacea (Bolten).

Ianthina violacea Bolten, Mus. Bolt., 75, 1798.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*I. ianthina*).

Specimens from the Kermadecs can be sorted out into two varieties, a larger conoidal form and a smaller depressed form, between which it seems impossible to draw a satisfactory line. Possibly the small depressed shells are young, and afterwards the descent of the body-whorl gives them a more conoidal appearance. But, of course, it must be admitted that if only four species are recognized in the genus, then *I. violacea* must be counted as very variable. I include *J. communis* Lam. and *J. balteata* Reeve of Suter's Manual under this species.

Habitat.—Live specimens cast up on the beaches at Sunday Island in large numbers, many having attached their rafts of eggs. Also found at Macauley Island.

Distribution.—All tropical seas, and extending well into the temperate zones. New Zealand, Lord Howe Island.

Ianthina globosa Swainson.

Ianthina globosa Swains., Zool. Illustr., ii, pl. 85, 1822.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Live specimens at certain times washed up in numbers on the beaches at Sunday Island.

Distribution.—Tropical and warm temperate seas. New Zealand.

Ianthina exigua Lamarck.

Ianthina exigua Lam., Anim. s. Vert., vi, 206, 1822.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Live specimens frequently cast up on the beaches at Sunday Island.

Distribution.—Tropical and warm temperate seas. New Zealand, Lord Howe Island.

Ianthina umbilicata d'Orbigny.

Ianthina umbilicata d'Orbigny, Voy. Amér. Mérid., 414, 1847.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Living adult specimens rarely, young at certain times frequently, washed up on the beaches at Sunday Island.

Distribution.—Lord Howe Island, Hawaii, North Pacific, Atlantic.

Recluzia lutea (Bennett).

Janthina lutea Bennett, Narr. Whaling Voy., ii, 298, 1840.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*R. hargravesii*).

Habitat.—Live specimens occasionally washed up on the beaches at Sunday Island.

Distribution.—Australia.

Cypraea caputserpentis Linné.

Cypraea caputserpentis Linné, Syst. Nat., ed. x, 720, 1758.
Recorded, Cheeseman, Trans. N.Z. Inst., 20, 165, 1888.

Habitat.—Live specimens rarely found in rock-pools and among rocks near low-water mark, Sunday Island (R. S. Bell).

Distribution.—Lord Howe Island, Norfolk Island, Australia, Pacific islands from New Caledonia to the Paumotus, Indian Ocean.

Cypraea carneola Linné.

Cypraea carneola Linné, Syst. Nat., ed. x, 719, 1758.

Habitat.—Dead shells found on the beaches, Sunday Island.

Distribution.—Australia, Pacific islands from New Caledonia to Hawaii, Indian Ocean.

Cypraea isabella Linné.

Cypraea isabella Linné, Syst. Nat., ed. x, 722, 1758.

Habitat.—Dead shells found on the beaches, Sunday Island.

Distribution.—Australia, New Guinea, Pacific islands from New Caledonia to Hawaii, Indian Ocean.

Cypraea erosa Linné.

Cypraea erosa Linné, Syst. Nat., ed. x, 723, 1758.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells occasionally washed up on the beaches at Sunday Island.

Distribution.—Indo-Pacific region.

Cypraea poraria Linné.

Cypraea poraria Linné, Syst. Nat., ed. x, 724, 1758.

Habitat.—One living specimen found among rocks in Denham Bay, Sunday Island (R. S. Bell).

Distribution.—Lord Howe Island, Australia, Pacific islands from New Caledonia to Hawaii.

Cypraea flaveola Linné.

Cypraea flaveola Linné, Syst. Nat., ed. x, 724, 1758.

Habitat.—Dead shells occasionally washed up on the beaches, Sunday Island.

Distribution.—Australia, Japan.

Trivia desirabilis Iredale.

Trivia desirabilis Iredale, Pro. Mal. Soc., x, 226, 1912.
Recorded, Iredale, *l.c.*

Habitat.—Dead shells occasionally washed up on the beaches, Sunday Island.

Trivia napolina (Keiner).

Cypraea napolina Kiener. Coq. Viv. 144.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—One dead shell found on beach, Sunday Island (Iredale).

Distribution.—Indo-Pacific region.

Erato lachryma Gray.

Erato lachryma Gray, Descr. Cat., 17, 1832.

Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells frequently dredged on gravelly bottom in 10 m. to 30 m. off Sunday Island.

Distribution.—Australia, Tasmania, Japan.

Charonia lampas (Linné).

Murex lampas Linné, Syst. Nat., ed. x, 748, 1758.

Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Septa rubicunda*).

Kermadec specimens vary a good deal in the shape of the shell and the size of the nodules. They appear to have the characters of both *C. rubicunda* and *C. nodifera* as defined by Hedley ("Endeavour" Results, 65, 1914).

Habitat.—Sunday Island. Live specimens up to 12 cm. in length on rocks about low-water mark. Dead shells washed up on the rocks attained a length of over 23 cm.

Distribution.—New Zealand, Tasmania, south-east Australia, Mediterranean, Atlantic, Japan.

Cymatium exaratum (Reeve).

Triton exaratus Reeve, Pro. Zool. Soc., 1844, 116, 1845.

Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—A few live and many dead specimens washed up on the beaches, Sunday Island.

Distribution.—New Zealand, Australia.

Cymatium spengleri (Chemnitz).

Murex spengleri Chemn., Conch. Cab., xi, 117, 1795.

Recorded, Cheeseman, Trans. N.Z. Inst., 20, 165, 1888 (*Triton*).

Habitat.—One live and many dead shells found on the beaches at Sunday Island.

Distribution.—New Zealand, Tasmania, Australia.

Cymatium dunkeri (Lischke).

Triton dunkeri Lischke, Mal. Blatt., xv, 219, 1868.

Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—A few imperfect dead shells found on the beaches at Sunday Island.

Distribution. Japan.

Cymatium caudatum (Gmelin).

Triton caudatum Gmelin, Syst. Nat., ed. xiii, 3535, 1791.

Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.

Distribution.—Australia.

Cymatium parthenopeum von Salis.

Murex parthenopeus von Salis, Reise Neapel, 370, 1793.

Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*C. costatum*).

Habitat.—Dead shells occasionally washed up on the beaches at Sunday Island.

Distribution.—New Zealand, Australia, Society Islands, Japan, Atlantic coasts.

Cymatium labiosum (Wood).

Murex labiosum Wood, Index Test. Suppl., 15, 1828.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells frequent on the beaches of Sunday Island.
Distribution.—Australia, Philippines, Indian Ocean.

Cymatium vespaceum Lamarck.

Triton vespaceum Lam., Anim. s. Vert., vii, 185, 1822.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.
Distribution.—Australia, Indian Ocean.

Cymatium waterhousei (Adams and Angas).

Triton waterhousei Ad. & Ang., Pro. Zool. Soc., 1864, 35, 1865.

Habitat.—Dead shells occasionally washed up on the beaches at Sunday Island.
Distribution.—South Australia.

Austrotriton parkinsoniana (Perry).

Septa parkinsoniana Perry, Conch., pl. 14, fig. 1, 1811.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Cymatium*).

Habitat.—A few broken dead shells found on the beaches at Sunday Island.
Distribution.—New Zealand, Australia.

Argobuccinum australasia (Perry).

Biplex australasia Perry, Conch., pl. 4, fig. 24, 1811.
Recorded, Cheeseman, Trans. N.Z. Inst., 20, 165, 1888 (*Ranella leucostoma*).

Habitat.—Common living on rocks at low-water mark, Meyer Island. Shells almost always much corroded.
Distribution.—Lord Howe Island, New Zealand.

Bursa siphonata (Reeve).

Ranella siphonata Reeve, Pro. Zool. Soc., 1844, 138, 1845.
Recorded, Suter, Trans. N.Z. Inst., 38, 328, 1906 (*Tutufa californica*).

Habitat.—Dead shells, rarely washed up on the beaches, Sunday Island. Cheeseman collected a shell on Denham Bay beach in 1887. I am aware of only three others collected since.
Distribution.—Philippines.

Bursa mammata Bolten.

Bursa mammata Bolten, Mus. Bolt. (2), 128, 1798.

Habitat.—Dead shells rarely washed up on the beaches at Sunday Island.
Distribution.—New Caledonia.

Bursa papilla (Wood).

Murex papilla Wood, Index Test. Suppl., 14, 1828.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Argobuccinum*).

Habitat.—Dead shells frequently washed up on the beaches at Sunday Island. A few live specimens also found.
Distribution.—Lord Howe Island.

Cassidea royana Iredale.

Cassidea royana Iredale, Pro. Mal. Soc., xi, 179, 1914.
Recorded, Cheeseman, Trans. N.Z. Inst., 20, 165, 1888 (*Cassis pyrum*).

Habitat.—One dead shell was found on Denham Bay beach, Sunday Island, by Mr. T. F. Cheeseman in 1887, and is now in the Auckland Museum. A second and imperfect specimen (the type) was brought back by Mr. Iredale, and is now in the Canterbury Museum.

Cassidea perryi Iredale.

Cassidea perryi Iredale, Pro. Mal. Soc., x, 227, 1912.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*C. cernica*).

The type specimen is 41 mm. long, and has a varix exactly similar to the outer lip, and 100° from it. I have not seen a varix on any other specimen.

Habitat.—Dead shells occasionally washed up on the beaches at Sunday Island. One live specimen was obtained in 1908.

Cassidea pyrum (Lamarck).

Cassis pyrum Lamarck, Anim. s. Vert., vii, 226, 1822.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Cassidea pyrum sophiae*).

Habitat.—One dead shell collected on beach (Iredale).
Distribution.—New Zealand, Tasmania, Australia.

Tonna perdix (Linné).

Buccinum perdix Linné, Syst. Nat., ed. x, 735, 1758.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Dolium*).

Habitat.—Dead shells rarely found on the beaches at Sunday Island; also one live specimen was found on Denham Bay beach in 1908.

Distribution.—Lord Howe Island, Australia, New Guinea, New Caledonia, Pacific, Atlantic, and Indian Oceans.

Cadium pomum (Linné).

Buccinum pomum Linné, Syst. Nat., ed. x, 735, 1758.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Dolium*).

Habitat.—Dead shells found on the beaches, Sunday Island.
Distribution.—Australia, New Guinea, Pacific islands from New Caledonia to the Society Islands, Philippines, Indian Ocean.

Architectonica radiata Bolten.

Architectonica radiata Bolten, Mus. Bolt., 1798.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*A. cingula*).

Habitat.—Dead shells found on the beaches, Sunday Island.
Distribution.—Lord Howe Island, Norfolk Island, Fiji, Hawaii, Philippines.

Heliacus variegatus (Gmelin).

Torinia variegatus Gmelin, Syst. Nat., ed. xiii, 3575, 1791.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.
Distribution.—New Zealand, Australia, Pacific and Indian Oceans.

Heliacus stramineus (Gmelin).

Torinia straminea Gmelin, Syst. Nat., ed. xiii, 3575, 1791.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.
Distribution.—Australia, New Guinea, Philippines, India.

Epitonium perplexum (Pease).

Scalaria perplexa Pease, Amer. Journ. Conch., iii, 228, 1867.
Recorded, Suter, Journ. Malac., vii, 54, 1899 (*Scalaria australis*).

Habitat.—Dead shells frequently washed up on the beaches, Sunday Island.
Distribution.—Norfolk Island, Indo-Pacific region.

Pyramidella terebelloides (A. Adams).

Obeliscus terebelloides A. Adams in Sowb. Thes. Conch., ii, 808, 1855.

Habitat.—Dead shells rarely dredged on gravelly bottom near Sunday Island.
Distribution.—Queensland, Funafuti, Hawaii.

Herviera isidella (Melvill and Standen).

Herviera isidella Melv. & Stand., Journ. Conch., ix, 186, 1898.

Habitat.—Dredged near Sunday Island (Iredale).
Distribution.—Loyalty Islands.

Turbonilla oceanica n. sp. Fig. 19.

Description of Type Specimen. — *Shell* subulate. Whorls 8, rounded, shouldered above, suture deeply impressed. Protoconch heterostrophe, of 1 whorl. Aperture ovate-rhomboid, the inner margin somewhat angled, the outer rounded. Outer lip thickened, inner lip thin, anteriorly raised above and separated from the body-whorl. *Sculpture:* Protoconch smooth. Shell with regular longitudinal ribs, there being about 18 on the body-whorl, where they terminate below the periphery. Interstices equal or slightly wider than the width of the ribs. *Colour* white, shining.

Height, 3 mm. Diameter, 0·8 mm.

Variations from Type.—Most of the specimens are about the same size as the type. One, however, has 9½ whorls, and measures 3·9 mm. in length.

Habitat.—Dead shells dredged on gravelly bottom in 10 m. to 30 m. off Sunday Island.

Turbonilla sculpturata n. sp. Fig. 20.

Description of Type Specimen.—*Shell* thin, subulate, but little tapered. Whorls 8½, loosely coiled, convex, suture deep. Protoconch heterostrophe, of 1 whorl. Aperture ovate-oblong, produced and rounded in front. Outer lip thin. Inner lip straight, produced and expanded anteriorly. *Sculpture:* Protoconch smooth. Shell with close, slightly oblique, narrow, longitudinal ribs, about 25 on the body-whorl. The interstices 2 or 3 times the width of the ribs. Ribs smooth, interstices with fine spiral striae. Base spirally striate. *Colour* white, translucent.

Height, 2·1 mm. Diameter, 0·5 mm.

Habitat.—Dead shells dredged on gravelly bottom in 10 m. to 30 m. off Sunday Island.

Odostomia clara Brazier.

Odostomia clara Brazier, Pro. Linn. Soc. N.S.W., i, 259, 1877.

Habitat. Dead shells dredged on gravelly bottom near Sunday Island.
Distribution.—Queensland.

Odostomia metata Hedley.

Odostomia metata Hedley, Pro. Linn. Soc. N.S.W., 32, 503, 1907.

Habitat.—Dead shells dredged on gravelly bottom near Sunday Island.
Distribution. Queensland.

Miralda austro-pacifica n. sp. Fig. 21.

Description of Type Specimen.—*Shell* ovate, apex blunt. Whorls 5½, flattened, suture deep. Aperture ovate, peristome not continuous. Outer lip thin. Inner lip thin, narrow. Columella with a small oblique plait, not reaching to the margin of the inner lip. *Sculpture:* Protoconch of 1 whorl, smooth. Adult whorls with 3 spiral ribs, increasing to 4 on the penultimate and with a fifth on the base. Upper two ribs nodulous, the remainder smooth. Nodules in the upper row smaller than in the lower row. There are faint microscopic axial growth-lines on the lower portions of the whorls. *Colour* white.

Height, 2·2 mm. Diameter, 0·9 mm.

This species appears to be closely related to *Odostomia scopulorum* Watson, from Hawaii.

Habitat.—Dead shells dredged in 10 m. to 30 m. on gravelly bottom off Sunday Island.

Hinemoa n. gen.

Shell ovate. Protoconch 1-whorled. Aperture ovate. Columella with a feeble plait. Sculpture of spiral ribs only.

Type.—*Hinemoa punicea* Oliver.

Hinemoa punicea n. sp. Fig. 22.

Description of Type Specimen.—*Shell* ovate, apex obtuse. Whorls 4½. Aperture broadly ovate. Outer lip thin. Inner lip anteriorly raised with a slight umbilical chink between it and the body-whorl. Columella-plait small, oblique. *Sculpture:* Protoconch of 1 whorl, smooth, polished. Shell with high rounded equidistant spiral ribs, 2 on each whorl, the distance between them equal to their width, and equal to the distance between those on each side of the suture, which is not distinguishable. Three additional low spiral ribs on the base. Otherwise the surface is quite smooth. *Colour:* Protoconch ruby-red, shining; shell light pink, whitish within the aperture.

Height, 1·1 mm. Diameter, 0·6 mm.

Habitat.—Dead shells dredged in 10 m. to 30 m. off Sunday Island; not common, but easily overlooked.

Pyrgulina insularis n. sp. Fig. 23.

Description of Type Specimen.—*Shell* ovate, apex obtuse. Whorls 5, flattened, angled at the suture, which is deep. Aperture rhomboid-ovate. Outer lip thin. Inner lip separated from the body-whorl below, leaving a deep umbilical chink. A feeble plait on the columella within. *Sculpture:* Protoconch smooth. Adult whorls with rounded longitudinal ribs, about 20 on the body-whorl. Interstices nearly twice the width of the ribs. On the body-whorl the ribs terminate at a spiral groove below the periphery,

above which there is another ill-defined spiral groove. Base with numerous growth-lines. *Colour* white.

Height, 2 mm. Diameter, 0·9 mm.

Habitat.—Dead shells dredged on gravelly bottom in 10 m. to 30 m. off Sunday Island.

Raoulostraca n. gen.

Shell elongate-ovate, obtuse. Body-whorl nearly half the length of the shell. Protoconch of 1 whorl, apex sinistral. Whorls flat, suture scarcely impressed. Aperture ovate. Inner lip thick, continuous to suture.

Type.—*Raoulostraca inexpectata* Oliver.

Raoulostraca inexpectata n. sp. Figs. 24 and 24*a*.

Description of Type Specimen.—*Shell* elongate-ovate, sides nearly straight. Apex sinistral, its convolution easily seen through the semi-transparent covering of the first adult whorl. Whorls 6, flat, suture but slightly marked. Aperture ovate. Outer lip thickened anteriorly. Inner lip thick, continued back to the suture with a distinct groove between it and the body-whorl. *Sculpture:* Shell quite smooth. *Colour* a rich brown, darkest on the upper part of the whorls.

Height, 4·4 mm. Diameter, 1·4 mm.

The type is an average-sized specimen. A single large specimen has 7 whorls, and measures—height, 6·3 mm.; diameter, 1·7 mm.

Habitat.—Dead shells abundant in dredgings on gravelly bottom in 10 m. to 30 m. off Sunday Island.

Melanella kermadecensis n. sp. Fig. 25.

Description of Type Specimen.—*Shell* subulate, apex blunt, right side nearly straight, left side slightly curved outwards. Whorls 6, flat, suture scarcely distinguishable. Aperture ovate, not much produced. Lip thick. Shell smooth, white, and shining.

Height, 2·8 mm. Diameter, 0·9 mm.

Habitat.—Dead shells common in dredgings on gravelly bottom in 10 m. to 30 m. off Sunday Island.

Melanella perplexa n. sp. Fig. 26.

Description of Type Specimen. — *Shell* subulate, tapered irregularly, apex acute. Right side nearly straight, but the apex tilted to one side; left side very slightly curved. Whorls 11, flat, suture scarcely marked. Aperture broadly ovate, the outer lip produced laterally beyond the line of the spire, and produced and expanded in front. Above the suture a spiral line is visible. Shell smooth, white, shining, translucent.

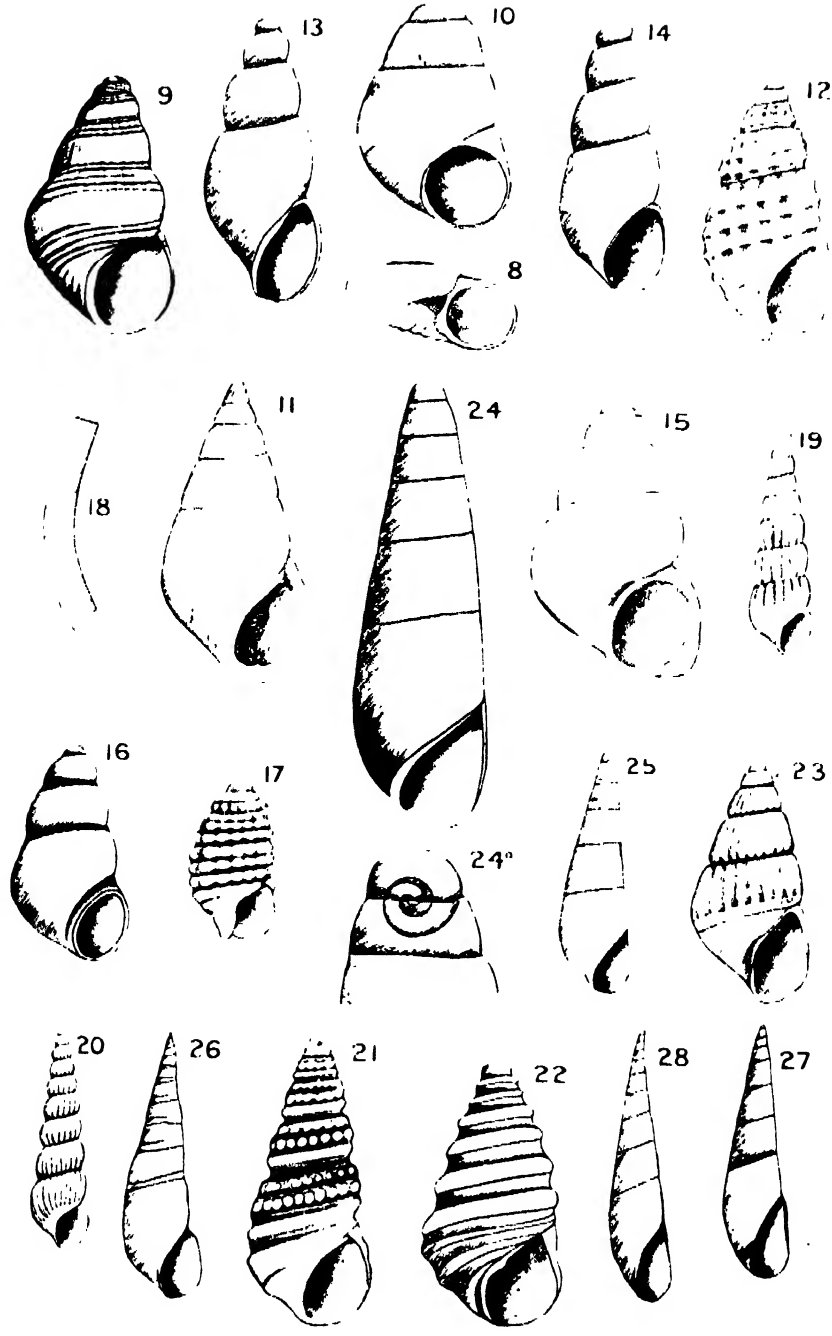
Height, 4·8 mm. Diameter above aperture, 1·4 mm.

A perplexing species, owing to the curious appearance of specimens of various ages of growth, caused by the tilted apex being at different angles to the aperture.

Habitat.—Dead shells abundant in dredgings on gravelly bottom in 10 m. to 30 m. off Sunday Island.

Melanella spinosa n. sp. Fig. 28.

Description of Type Specimen.—*Shell* narrow subulate, slightly curved to the right, the greatest curvature being near the apex. Whorls 10, flat,



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sutural line distinct, body-whorl about one-third the length of the shell. Aperture narrowly ovate. Inner lip thick, narrowing posteriorly, extending right back to the suture with a distinct groove between it and the body-whorl. *Sculpture:* Shell smooth, a spiral line above the sutural line. *Colour* white, transparent, the internal structure being clearly visible through the shell.

Height, 4·7 mm. Diameter, 1 mm.

Habitat.—A few dead shells dredged on gravelly bottom near Sunday Island.

Subularia perspicua n. sp. Fig. 27.

Description of Type Specimen.—*Shell* subulate, right side straight, left side nearly straight from apex to periphery of body-whorl, which then contracts towards the anterior end. Apex acute. Whorls 8, flat, suture scarcely distinct, body-whorl a little less than half the length of the shell. Aperture narrowly ovate. *Sculpture:* Shell smooth, a faint spiral line visible above the sutural line. *Colour:* Protoconch white. Spire yellowish-white, suture darker, the body-whorl white, faintly irregularly blotched with yellowish. A diagonal yellowish band across the columella anteriorly. Semi-transparent, the internal structure being visible through the shell.

Height, 3 mm. Diameter, 0·8 mm.

Habitat.—Dead shells dredged on gravelly bottom near Sunday Island.

Cithna wallacei n. sp. Fig. 29.

Description of Type Specimen.—*Shell* thin, glassy, ovate, apex blunt. Whorls 5, rounded, suture deeply impressed. Aperture broadly ovate, peristome thin. A narrow umbilical groove between the inner lip and the body-whorl. *Sculpture:* The whole shell quite smooth. *Colour:* Protoconch white. Adult whorls glassy, variegated with brown blotches. On the upper portion of the whorls these take the form of irregular brown diagonal bands, which at first slant forwards, then turn at right angles as narrow bands. The lower part of the spire-whorls with a few small brown patches. A clear peripheral band on the body-whorl, but narrow axial brown stripes round the base.

Height, 1·7 mm. Diameter, 1 mm.

Habitat.—Dead shells common in dredgings in 10 m. to 30 m. off Sunday Island.

Scalenostoma suteri n. sp. Fig. 30.

Description of Type Specimen. — *Shell* thin, turreted, sides straight, apex bluntly acuminate. Whorls 9, angular, sloping away on each side from the upper keel. Suture impressed. Aperture narrowly ovate, produced and truncated in front. Outer lip thick. Inner lip thick, a callosity at its anterior end, and a slight umbilical groove between it and the body-whorl, both lip and groove being continuous right back to the suture. *Sculpture:* Protoconch of 1 whorl, smooth. On the succeeding whorls are two high spiral keels, the upper of which is the higher. The ends of the spirals appear as two prominent projections on the outer lip. Entire surface of shell quite smooth. *Colour* white, translucent.

Height, 4·2 mm. Diameter, 1·2 mm.

Habitat.—Dead shells abundant in dredgings on gravelly bottom in 10 m. to 30 m. off Sunday Island.

Atlanta fusca Eydoux and Souleyet.

Atlanta fusca Eyd. & Soul., Voy. "Bonite," Zool., ii, 389, 1852.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells frequently washed up on the beaches at Sunday Island.

Distribution.—All seas.

Fusinus toreuma (Martyn).

Buccinum toreuma Martyn, Univ. Conch., i, t. 56, 1784.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Colus*).

Habitat.—Dredged alive in 30 m. near Meyer Island (W. S. Bell).

Distribution.—Indo-Pacific region.

Mitra mitra (Linné).

Voluta mitra var. *episcopalis* Linné, Syst. Nat., ed. x, 732, 1758.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.

Distribution.—Australia, Indo-Pacific region.

Mitra carbonaria Swainson.

Mitra carbonaria Swainson, Bligh Cat. Append., 10, 1822.
Recorded, Iredale, Pro. Mal. Soc., ix, 77, 1910.

Habitat.—Dead shells found on the beaches at Sunday Island.

Distribution.—New Zealand, New South Wales.

Mitra lanceolata Hervier.

Mitra lanceolata Hervier, Journ. de Conch., 45, 64, 1897.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells found on the beaches at Sunday Island.

Distribution.—Lifu.

Maculotriton bracteatus (Hinds).

Triton bracteatus Hinds, Pro. Zool. Soc., 1844, 21, 1845.

Habitat.—One dead shell collected by R. S. Bell at Sunday Island.

Distribution.—Lord Howe Island, Australia, Loyalty Islands, Malacca Straits, Marquesas, New Ireland, Henderson Island (East Pacific).

Jeannea hedleyi Iredale.

Jeannea hedleyi Iredale, Pro. Mal. Soc., x, 220, 1912.
Recorded, Iredale, *l.c.*

Habitat.—Living among rocks near low-water mark, Sunday Island; fairly common in places.

Arcularia spiratus (A. Adams).

Nassa spirata A. Adams, Pro. Zool. Soc., 1851, 106, 1852.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Alectrion*).

Habitat.—Living in sand among rocks at Coral Bay, Sunday Island (R. S. Bell).

Distribution.—Lord Howe Island, Norfolk Island, New Zealand, Australia.

Arcularia gaudiosus (Hinds).

Nassa gaudiosa Hinds, Voy. "Sulphur," 36, 1844.
Recorded, Suter, Trans. N.Z. Inst., 38, 331, 1906 (*Nassa zonalis*).

Habitat.—Dead shells frequently washed up on the beaches at Sunday Island.

Fossil.—In coarse gravel cemented by calcite, Titi Knob, Sunday Island. (*Nassa* sp. Oliver, Trans. N.Z. Inst., 43, 530, 1911.)

Distribution.—Pacific Ocean, Malaya.

Arcularia scalaris (A. Adams).

Nassa scalaris A. Adams, Pro. Zool. Soc., 1851, 108, 1852.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Alectrion*).

Habitat.—A few dead and broken shells found on the beaches at Sunday Island.

Distribution.—Philippines.

Murex zelandicus Quoy and Gaimard.

Murex zelandicus Q. & G., Voy. "Astrolabe," ii, 529, 1833.
Recorded, Watson, "Challenger" Rep., xv, pt. 42, 157, 1886.

Habitat.—Dredged in 1,100 m. on hard ground north of Sunday Island ("Challenger" Expedition).

Distribution.—New Zealand, Tongatabu.

Hexaplex puniceus n. sp. Fig. 31.

Description of Type Specimen.—*Shell* rhomboidal, the spire about half the length of the shell. Aperture ovate-elliptical. Canal less than the length of the aperture, straight, slightly deflected to the left and its anterior end upturned. Whorls 4½, suture deep. Outer lip formed of the last axial ridge, broad, with 4 transverse ridges. A slight umbilical fissure between the inner lip, and a short false canal opposite the anterior end of the aperture. *Sculpture:* Protoconch of 1 whorl, smooth. Spire-whorls with 2 high spiral keels, crossed by prominent longitudinal ridges, forming nodules at the intersections. Body-whorl with 9 high axial ridges (the last forming the outer lip), and crossed by 4 spiral ridges, forming nodules at the intersections. The two upper spiral ridges on the shoulder are higher than the two lower. A fifth spiral ridge on the canal above. *Colour* pink.

Height, 4·6 mm. Diameter, 2·6 mm.

Habitat.—A few dead and broken shells dredged in 10 m. to 30 m. off Sunday Island.

Trophon subtropicalis Iredale.

Trophon subtropicalis Iredale, Pro. Mal. Soc., x, 227, 1912.
Recorded, Iredale, *l.c.*

Habitat.—Dead shells abundant in dredgings on gravelly bottom in 10 m. to 30 m. off Sunday Island.

Neothais succincta (Martyn).

Buccinum succinctum Martyn, Univ. Conch., ii, fig. 45, 1784.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Thais*).

Habitat.—Living specimens taken at Sunday Island by R. S. Bell.

Distribution.—Lord Howe Island, Norfolk Island, New Zealand, Tasmania, Australia.

Neothais chaidea (Duclos).

Drupa chaidea Duclos, Ann. Sci. Nat., 106, 1834.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Thais*).

Habitat.—Living under stones near low-water mark, Coral Bay, Sunday Island; not common.
Distribution.—Lord Howe Island, Norfolk Island, New Caledonia, Australia.

Neothais smithi (Brazier).

Purpura smithi Brazier, Mem. Aust. Mus., ii, pl. 4, 1889 (no description).
Recorded, Suter, Trans. N.Z. Inst., 38, 331, 1906 (*Purapura striata bollonsii*).

Habitat.—Common living on rocks between tide-marks at Sunday Island.
Distribution.—Lord Howe Island, Norfolk Island, New Zealand.

Neothais dealbata (Reeve).

Ricinula dealbata Reeve, Conch. Icon., iii, sp. 26, 1846.

Habitat.—Dead shells frequently washed up on the beaches, Sunday Island.
Distribution.—Philippines, South Pacific Ocean.

Columbella versicolor Sowerby.

Columbella versicolor Sowb., Pro. Zool. Soc., 1832, 119, 1833.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Living under stones at low-water mark, Coral Bay, Sunday Island; not common.
Distribution.—Lord Howe Island, Australia, Philippines, Japan, Indian and Pacific Oceans.

Columbella varians Sowerby.

Columbella varians Sowb., Pro. Zool. Soc., 1832, 116, 1833.

Habitat.—Dead shells collected at Sunday Island by R. S. Bell.
Distribution.—Lord Howe Island, Australia, New Guinea, New Caledonia eastwards to Hawaii, Galapagos Islands, Philippines.

Coralliophila neritoidea (Lamarck).

Pyrula neritoidea Lam., Anim. s. Vert., vii, 146, 1822.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.
Distribution.—Pacific Ocean.

Coralliophila nivea (A. Adams).

Rhizochilus nivea A. Adams, Mazat. Cat., 484.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Taken alive at Sunday Island by W. S. Bell.
Fossil.—In hard sandy volcanic tuffs of submarine origin, Deyrell Islet. (*Purpura* sp. Oliver, Trans. N.Z. Inst., 43, 527.)
Distribution.—America.

Coralliophila lischkeana (Dunker).

Rapana lischkeana Dunker, Index Moll. Mar. Japan, 43, 1882.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells rarely found on the beaches at Sunday Island.
Distribution.—Australia, Japan.

Quoyula madreporarium (Sowerby).

Purpura madreporarium Sowerby, Gen. *Purpura*, 1832.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Coralliophila monodonta*).

Habitat.—Abundant, living on coral attached to rocks in 1 m. to 4 m., Sunday Island and Meyer Island.
Distribution.—Australia, Pacific Islands.

Magilus antiquus Montfort.

Magilus antiquus Montfort, Conch. Syst. 43, 1810.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Living in coral in 1 m. to 4 m., Meyer Island.
Distribution.—Solomon Islands, Indian and Pacific Oceans.

Lyria nucleus (Lamarck).

Voluta nucleus Lam., Ann. Mus., xvii, 73, 1811.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells occasionally washed up on the beaches at Sunday Island.
Distribution.—Lord Howe Island, Norfolk Island, Australia.

Marginella mustelina (Angas).

Hyalina mustelina Angas, Pro. Zool. Soc., 1871, 14, 1872.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells dredged on gravelly bottom in 10 m. to 30 m. off Sunday Island.
Distribution.—New Zealand, Australia.

Marginella angasi Brazier.

Marginella angasi Brazier, Journ. de Conch., 304, 1870.

Habitat.—Dead shells dredged on gravelly bottom, Sunday Island.
Distribution.—New South Wales.

Turris cingulifera (Lamarck).

Pleurotoma cingulifera Lam., Anim. s. Vert., vii, 94, 1822.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—A few dead shells found on the beaches, Sunday Island.
Distribution.—Indo-Pacific region.

Mangilia bella (Pease).

Daphnella bella Pease, Pro. Zool. Soc., 1860, 147, 1861.

Habitat.—Dead shells dredged in 10 m. to 30 m. on gravelly bottom near Sunday Island.
Distribution.—Hawaii.

Mangilia hedleyi n. sp. Fig. 32.

Description of Type Specimen.—*Shell* fusiform, the spire more than 1½ times the length of the aperture. Whorls 7½, prominently angled above the periphery, suture deep. Aperture narrow oblong, slightly oblique, angled behind, truncate in front. Outer lip rather thick with sharp edge, sinus deep and broad, separated from the body-whorl by a slight callus. Inner lip narrow and thin. Canal short, wide. *Sculpture:* Protoconch of 3 whorls, the upper quite smooth, the lower two with a spiral peripheral rib, otherwise smooth. Adult whorls with prominent axial ridges, about 15 on the body-whorl, terminating above the slightly contracted base. The whole shell crossed by close spiral ribs, of which one is prominent on all the whorls at the angle above the periphery, and on the penultimate and body-whorls two others are prominent below this. *Colour:* Protoconch white, shining, the extreme tip brown. Shell creamy white, with a broad dark-brown spiral band at the suture, and continued over the base of the body-whorl below the periphery. The extreme anterior end of the shell, the edge of the outer lip, and a small patch on the body-whorl near it are similarly coloured. The brown colour passes through the shell, and appears distinctly in the interior of the aperture.

Height, 6 mm. Diameter, 2·5 mm.

Habitat.—Dead shells dredged in 10 m. to 30 m. on gravelly bottom near Sunday Island.

Glyphostoma roseocincta n. sp. Fig. 33.

Description of Type Specimen.—*Shell* broadly fusiform the aperture slightly less than half the length of the shell. Whorls 5½, angled at the periphery, suture deep. Aperture narrow rhomboid-oblique. Outer lip thickened, denticulate within. Sinus deep, its posterior edge a small callous ridge on the body-whorl. Inner lip thin, narrow. Columella with folds very faintly indicated. Canal wide. *Sculpture:* Protoconch 1¾ whorls, smooth. Shell with high axial ridges, 12 on the body-whorl, becoming obsolete on the base. The whole crossed by regular equidistant raised spiral threads, the interstices 2 or 3 times the width of the threads. *Colour* pink, a broad spiral dark brownish-pink band at the suture and extended round the base of the body-whorl.

Height, 4 mm. Diameter, 2 mm.

Variations from Type.—In most specimens no columellar folds can be distinguished.

Habitat.—Dead shells fairly common in dredgings in 10 m. to 30 m. on gravelly bottom near Sunday Island.

Iredalea n. gen.

Shell narrow fusiform, turreted, the aperture about a third the length of the shell. Canal short, wide. Sinus deep and broad, separated from the body-whorl by a callosity. Protoconch of 4 whorls, *sinusigera* in form.

Type.—*Iredalea subtropicalis* Oliver.

Iredalea subtropicalis n. sp. Fig. 34.

Description of Type Specimen.—*Shell* narrow, fusiform, truncated anteriorly, aperture one-third the length of the shell. Whorls 9, of which the protoconch forms 4, flatly rounded, suture impressed. Protoconch *sinusigera* in form, the exposed portion of its lower lip concave. Aperture

narrow oblong, obliquely angled behind, truncated in front. Outer lip thick, smooth within. Sinus deep, separated from the body-whorl by a thick callous ridge. Columella smooth within. Canal short, wide. *Sculpture:* Protoconch smooth. Shell with regular low axial ridges, about 15 on the body-whorl, slightly constricted at their upper ends near the suture. The ridges extend on to the base of the shell, which at its anterior end has 4 oblique low ridges. Entire surface of shell smooth and shining. *Colour:* Protoconch dark yellow. Shell white, with a faint brown band, dark in patches, along the lower edge of the whorls, but not reaching the outer lip, where, at its anterior end, 2 narrow brown bands are very faintly indicated.

Height, 6·2 mm. Diameter, 2·2 mm.

Habitat.—Dead shells in dredgings in 10 m. to 30 m. on gravelly bottom off Sunday Island; not common.

Kermia n. gen.

Shell fusiform, aperture narrow, nearly half the length of the shell. Canal short and wide. Sinus deep, near the suture, surrounded by a thick lip. Protoconch of 2 whorls. Outer lip thick, denticulate within. Columella smooth.

Type.—*Kermia benhami* Oliver.

Kermia benhami n. sp. Fig. 35.

Description of Type Specimen.—*Shell* fusiform, the body-whorl more than half the length of the shell. Whorls 6½, flatly rounded, suture deep. Aperture narrow, slightly oblique, sinuous. Outer lip thick, slightly expanded, denticulate within. Sinus deep and broad, near the suture, but surrounded by a thick lip. Inner lip thin, narrow. Columella smooth. *Sculpture:* Protoconch with 1st whorl smooth, the 2nd crossed by threads which, beginning at the upper suture, pass first longitudinally and singly, then at the periphery bifurcate, each branch passing obliquely to the suture, thus reticulating the lower half. Adult whorls entirely reticulated by axial ribs, about 8 on the first whorl and 20 on the body-whorl, overridden by less prominent and narrower spiral ribs, forming transverse beads at the intersections. There are 2 spirals on the first adult whorl, 5 on the penultimate (of which the two upper are smaller than the others), and 13 on the body-whorl counting just behind the outer lip. Of these, the two upper are less prominent than the others. Interstices deep, between the spirals 2 to 3 times the width of the latter, and between the axials about 1½ times the width of the ribs. At the anterior end of the body-whorl the spirals are more prominent than the axials. The transverse ribs of the body-whorl extend over the expanded outer lip. Under the microscope the whole surface is seen to be finely spirally striated. *Colour:* Protoconch light brown, remainder of shell uniformly dark brown. Outer lip with a white patch at the sinus and another near the centre. Inner lip and interior of aperture pale brown.

Height, 4 mm. Diameter, 1·5 mm.

Habitat.—Dead shells abundant in dredgings in 10 m. to 30 m. on gravelly bottom near Sunday Island.

Mitramorpha expeditionis n. sp. Fig. 36.

Description of Type Specimen.—*Shell* broadly fusiform, broadest about the middle, aperture equal in length to the spire. Whorls 6½, flattened,

suture impressed, the body-whorl ventricose, regularly tapered in front. Aperture long, oblique, posteriorly deflected to the right. Outer lip not thin, acute. Sinus near the suture, deep, with a thick rim. Inner lip broad, thin. Columella flattened, with 2 obscure plications near the middle. Canal short, wide, truncate in front. *Sculpture:* Protoconch of 1½ whorls, smooth. First adult whorl with 2 spiral threads on the periphery, 2nd with 10 sinuous axial ridges overridden by fine spiral threads. The succeeding two whorls are similarly sculptured, the axial ridges and spiral threads being more numerous. Body-whorl with low axial ridges, sinuous near the suture and becoming obsolete at the periphery, the whole overridden by close regular spiral threads. *Colour:* Dark buff, a faint purple spiral band on the lower edge of the spire-whorls. On the body-whorl are sinuous brown marks near the suture.

Height, 5·2 mm. Diameter, 2·2 mm.

Variations from Type.—The colour varies from white to buff, most shells being ornamented with a few irregular brown marks.

Habitat.—Dead shells dredged in 10 m. to 30 m. on gravelly bottom off Sunday Island.

Zafra kermadecensis n. sp. Fig. 37.

Description of Type Specimen.—*Shell* broadly fusiform, apex obtuse. Whorls 4½, with a flattened periphery, shouldered, suture deep. Aperture narrow, rhomboidal, the outer and inner lips parallel, obliquely truncated in front and behind. Outer lip with a broad and shallow sinus at the suture. Inner lip distinct throughout, narrow and slightly thickened along its straight central and anterior portion. Canal short, wide. *Sculpture:* Protoconch of 1 whorl, smooth. Shell with low rounded axial plications, about 15 on each whorl. Base of body-whorl with several oblique plications. Surface of shell smooth and shining. *Colour:* Protoconch white. Shell glassy, tinged with yellowish. A spiral row of rectangular light yellowish-brown patches on the spire-whorls, one on each alternate plication, and extending from above the periphery to the lower suture. This row is continued on the periphery of the body-whorl. Below it is a clear spiral band, the base being more or less coloured with the same yellowish-brown. Tip of canal clear.

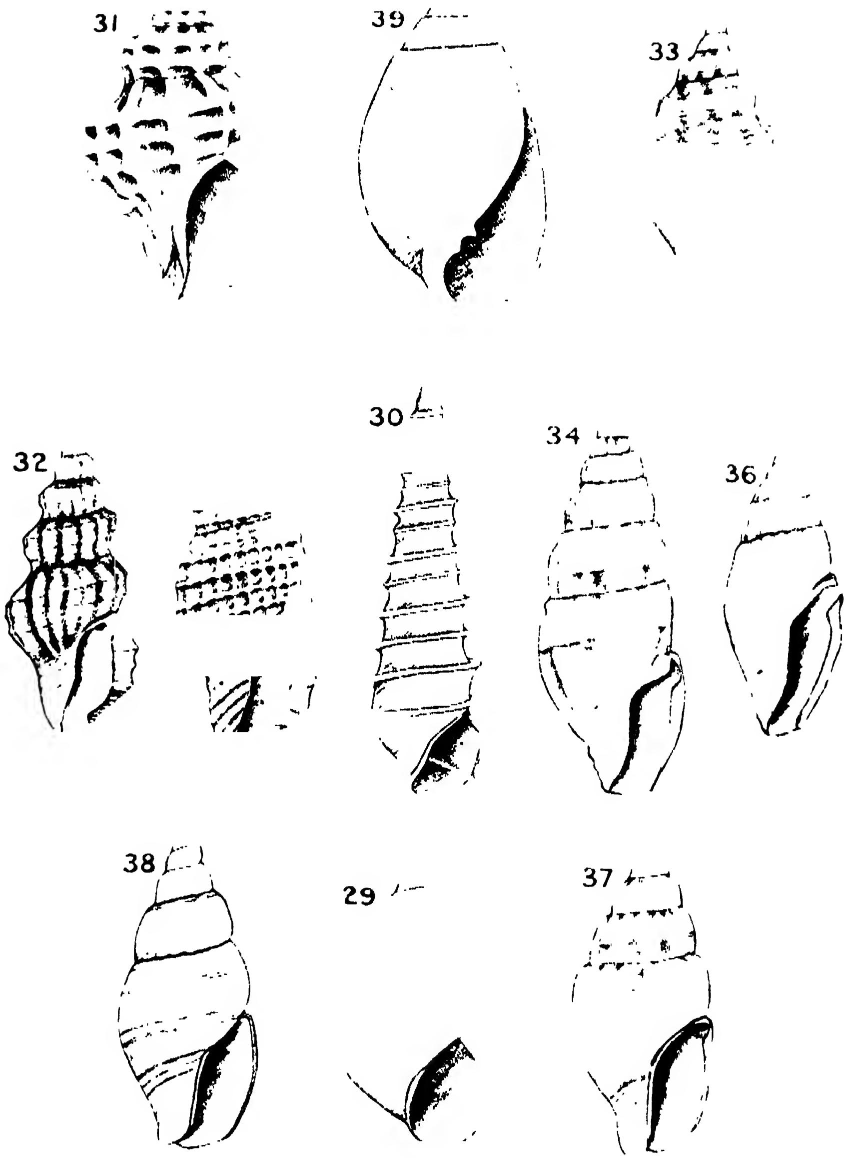
Height, 2·3 mm. Diameter, 1 mm.

Variations from Type.—In some specimens the clear bands above and below the periphery of the body-whorl are ornamented with semicircular brown markings, with their convexity directed towards the aperture.

Habitat.—Dead shells abundant in dredgings on gravelly bottom in 10 m. to 30 m. off Sunday Island.

Zafra fuscolineata n. sp. Fig. 38.

Description of Type Specimen.—*Shell* broadly fusiform, truncate in front, apex obtuse. Whorls 5, flatly rounded, suture impressed. Aperture oblong, slightly produced in front, outer edge nearly straight, inner edge angled above. Outer lip thin, sinus at the suture, shallow. Inner lip thickened, straight below. Canal short, wide. *Sculpture:* Protoconch of 1½ whorls, smooth. Adult whorls with low, slightly oblique, axial ridges, about 15 on the penultimate whorl, and becoming obsolete on the periphery of the body-whorl. Interstices very shallow, concave. Base with oblique grooves. Over the whole shell there appears under the microscope



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fine close spiral striae. *Colour :* Protoconch white, with a spiral brown band in the suture. Remainder of shell creamy white, with a white peripheral band, and light-brown spiral lines disposed as follows : On the spire-whorls, 2, one each side of the white median band, and with a third near the upper suture on the penultimate whorl ; on the body-whorl, 1 near the suture, 1 (double) above the white peripheral band, 2 below it, and 3 on the base.

Height, 2·5 mm. Diameter, 1·2 mm.

Variations from Type.—The brown spiral lines vary somewhat in different shells. The line above the periphery on the body-whorl is usually single, while there may be as many as 6 lines on the base.

Habitat.—A few dead shells dredged on gravelly bottom in 10 m. to 30 m. near Sunday Island.

Terebra venosa Hinds.

Terebra venosa Hinds, Pro. Zool. Soc., 1843, 157, 1844.
Recorded, Suter, Trans. N.Z. Inst., 38, 332, 1906.

Habitat.—Dead shells washed up on the beaches, Sunday Island, in large numbers.

Distribution.—Mauritius, Seychelles.

Terebra circumcincta Deshayes.

Terebra circumcincta Desh., Journ. Conch., 77, pl. 3, fig. 9, 1857.

Habitat.—Dredged alive in 30 m. near Sunday Island (R. S. Bell).

Distribution.—Australia, Red Sea.

Conus kermadecensis Iredale.

Conus kermadecensis Iredale, Pro. Mal. Soc., x, 227, 1912.
Recorded, Iredale, *l.c.*

Shells somewhat variable in shape. Two type specimens are in the Canterbury Museum—(*a.*) Height, 47 mm. ; diameter, 24 mm. ; spire angle, 100°. (*b.*) Height, 43 mm. ; diameter, 26 mm. ; spire angle, 140°.

Habitat.—Living on rocks just below low-water mark, Meyer Island; common.

Conus vermiculatus Lamarck.

Conus vermiculatus Lam., Anim. s. Vert., vii, 452, 1822.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Perhaps Cheeseman's record of *C. marmoreus* (Trans. N.Z. Inst., 20, 165, 1888) belongs here, as the specimens were small, but they cannot now be found.

Habitat.—Dead shells found on the beaches, Sunday Island.

Distribution.—Lord Howe Island, Pacific Ocean.

Conus minimus Gmelin.

Conus minimus Gmelin, Syst. Nat., ed. xii, 3382, 1791.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells occasionally found on the beaches at Sunday Island.

Distribution.—Lord Howe Island, Norfolk Island, Indian Ocean, Malaya, New Caledonia.

Conus maculosus Sowerby.

Conus maculosus Sowb., Conch. Illustr., *Conus*, pl. 1, fig. 3, 1833.

Habitat.—A few dead and broken shells found on the beaches at Sunday Island.

Distribution.—Lord Howe Island, Australia, Philippines.

Conus virgo Gmelin.

Conus virgo Gmelin, Syst. Nat., ed. xiii, 3376, 1791.

Habitat.—One imperfect dead shell found on the shore, Sunday Island (R. S. Bell).

Distribution.—New Caledonia, Indian and Pacific Oceans, Malaya.

Acteon flammeus (Gmelin).

Voluta flammeus Gmelin, Syst. Nat., ed. xiii, 3435, 1791.

Habitat.—Dredged alive in 35 m. near Sunday Island.

Distribution.—Indian and Pacific Oceans, Java, Philippines, Australia.

Bullinula ziczac (Muhlfeldt).

Voluta ziczac Muhl., Ges. Nat. Fr. Berlin, Mag. neu. Entdeck, viii, 5, 1818.

Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*Bullina scabra*).

Habitat.—A few dead shells found on the beaches, Sunday Island.

Distribution.—Norfolk Island, New Zealand, Tasmania, Australia, Pacific and Indian Oceans, Java.

Pugnus parvus Hedley.

Pugnus parvus Hedley, Rec. Austr. Mus., ii, 106, 1896.

Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—A few dead shells dredged on gravelly bottom near Sunday Island.

Distribution.—New South Wales.

Tornatina apicina Gould.

Tornatina apicina Gould, Pro. Bost. Soc. N.H., vii, 139, 1859.

Habitat.—Dead shells abundant in dredgings in 10 m. to 30 m. on gravelly bottom near Sunday Island.

Distribution.—New South Wales.

Cylichnella thetidis (Hedley).

Cylichna thetidis Hedley, Mem. Austr. Mus., iv, 395, 1903.

Habitat.—Dead shells dredged in 10 m. to 30 m. on gravelly bottom near Sunday Island.

Distribution.—New Zealand, Australia.

Bullaria peasiana Pilsbry.

Bullaria peasiana Pilsbry, Man. Conch. (i), xv, 348, 1893.

Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*B. ampulla*).

Habitat.—Dead shells frequently washed up on the beaches, Sunday Island.

Distribution.—Lord Howe Island, Norfolk Island, Sandwich Islands.

Limacina bulimoides (d'Orbigny).

Atlanta bulimoides d'Orb., Voy. Amér. Mérid., v, 179, 1836.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells washed up on the beaches, Sunday Island.
Distribution.—All tropical and warm temperate seas.

Limacina inflata (d'Orbigny).

Atlanta inflata d'Orb., Voy. Amér. Mérid., v, 174, 1836.

Habitat.—Dead shells occasionally washed up on the beaches, Sunday Island.
Distribution.—All tropical and warm temperate seas.

Styliola subula (Quoy and Gaimard).

Cleodora subula Q. & G., Ann. Sci. Nat., x, 233, 1827.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.
Distribution.—All tropical and warm temperate seas.

Clio pyramidata Linné.

Clio pyramidata Linné, Syst. Nat., ed. xii, 1094, 1767.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.
Distribution.—All tropical and temperate seas.

Clio acicula (Rang).

Creseis acicula Rang, Ann. Sci. Nat., i, 318, 1828.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells washed up on the beaches, Sunday Island.
Distribution.—All tropical and warm temperate seas.

Clio virgula (Rang).

Creseis virgula Rang, Ann. Sci. Nat., i, 316, 1828.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells washed up on the beaches, Sunday Island.
Distribution.—All tropical and warm temperate seas.

Cuvierina columnella (Rang).

Cuvieria columella Rang, Ann. Sci. Nat. (i), xiii, 323, 1827.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells frequently washed up on the beaches, Sunday Island.
Distribution.—New Zealand; all tropical and warm temperate seas.

Cavolina telemus (Linné).

Monoculus telemus Linné, Syst. Nat., ed. x, 635, 1758.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*C. tridentata*).

Habitat.—Dead shells found on the beaches, Sunday Island.
Distribution.—New Zealand; all tropical and warm temperate seas.

Cavolina trispinosa (Lesueur).

Hyalaea trispinosa Les. in Blainv. Dict. Sci. Nat., xxii, 82, 1821.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells washed up on the beaches, Sunday Island.
Distribution.—New Zealand; all tropical and warm temperate seas.

Cavolina longirostris (Lesueur).

Hyalaea longirostris Les. in Blainv. Dict. Sci. Nat., xxii, 81, 1821.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Kermadec specimens belong to the variety *strangulata* Hedley (Rec. Austr. Mus., vi, 299, 1907).
Habitat.—Dead shells frequently washed up on the beaches, Sunday Island.
Distribution.—New Zealand; all tropical and temperate seas.

Cavolina inflexa (Lesueur).

Hyalaea inflexa Les., Nouv. Bull. Soc. Philom., iii, 285, 1813.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.
Distribution.—New Zealand; all tropical and warm temperate seas.

Cavolina gibbosa (Rang).

Hyalaea gibbosa Rang in d'Orb. Voy. Amér. Mérid., v, 95, 1836.

Habitat.—Dead shells rarely washed up on the beaches at Sunday Island.
Distribution.—All tropical and warm temperate seas.

Cavolina quadridentata (Lesueur).

Hyalaea quadridentata Lesueur in Blainv. Dict. Sci. Nat., xxii, 81, 1821.

Habitat.—Dead shells rarely washed up on the beaches, Sunday Island.
Distribution.—All tropical and warm temperate seas.

Theceurybia gaudichaudi (Souleyet).

Euribia gaudichaudi Soul., Voy. "Bonite," Zool., t. 2, p. 253, 1852.
Recorded, Pelseneer, "Challenger" Rep., xix, pt. 58, 55, 1887.

Habitat.—Taken on the surface of the ocean between Sunday and Macauley Islands ("Challenger" Expedition).
Distribution.—Philippines.

Umbraculum umbellum (Martyn).

Patella umbella Martyn, Un. Conch., iii, pl. 102, 1786.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Living among rocks near low-water mark, Coral Bay, Sunday Island.
Distribution.—Norfolk Island, New Zealand, Australia, Indian and Pacific Oceans.

Heteroplocamus n. gen. for *Euplocamus* Philippi, preoccupied.

Type.—*Euplocamus pacificus* Bergh.

Heteroplocamus pacificus Bergh.

Euplocamus pacificus Bergh, "Challenger" Rep., x, pt. 26, 57, 1884. Recorded, Bergh, *l.c.*

Habitat.—Dredged in 1,150 m., between Sunday and Macauley Islands, on volcanic mud ("Challenger" Expedition).

Glaucilla atlanticus (Forster).

Glaucus atlanticus Forster, Voy. "Resolution," i, 49, 1777.

Habitat.—Live specimens frequently washed up on the beaches, Sunday Island.

Distribution.—Atlantic Ocean.

Leuconopsis pacifica n. sp. Fig. 39.

Description of Type Specimen.—*Shell* thin, ovate, apex obtuse. Whorls 4, those of the spire flat, shouldered above, their sides nearly parallel, and, as they decrease in size towards the apex, form a step-like series. Aperture narrowly pyriform. Outer lip thick in front, suddenly becoming thin behind with a free rounded edge, thus forming a narrow posterior canal. Inner lip a broad callous smear. Columella with 3 plaits, the central one largest. Shell smooth with axial growth-lines, white.

Height, 2·7 mm. Diameter, 1·5 mm.

Variations from Type.—The upper columella plication, weak in the type, is absent in all other specimens. The type is the largest specimen seen.

Habitat.—Dead shells rarely found in dredgings in 10 m. to 30 m. off Sunday Island.

Melampus albus Gassies.

Melampus albus Gassies, Journ. Conch., xiii, 211, 1865.

Habitat.—Dead shells dredged on gravelly bottom near Sunday Island.

Distribution.—New Caledonia.

Siphonaria.

The representatives of this genus in the Kermadec Islands recall *Cellana* in the multiplicity of forms and the difficulty of dividing them into specific groups with satisfactory limits. I have a good series of specimens from Sunday Island, Macauley Island, and French Rock, and on comparing them with what specimens are available to me from Norfolk Island, New Zealand, Australia, and Tasmania I find that all appear to be distinct from the species of those countries. The chief affinities lie with Norfolk Island and New Zealand. I separate the Kermadec specimens into four species. Here, as in *Cellana*, there seems to be some relation between specific divergence on the one hand, and habitat and distribution on the other, for the three principal species found at Sunday Island affect distinct habitats, while the dominant forms on Macauley Island and French Rock differ from each other and from those on Sunday Island. Hiding in crevices of rocks near high-water mark on Sunday Island is the small *S. amphibia*; lower down the high and polished *S. raoulensis* occurs; while near low-water mark is found abundantly the remarkable *S. cheesemani*, usually coated with crustaceous algae, and often adhering to the great shells of *Scutellastra kermadecensis*.

Siphonaria raoulensis n. sp. Figs. 40 and 40*a*.

Recorded, Suter, Trans. N.Z. Inst., 39, 265 (*S. diemenensis*).

Description of Type Specimen.—*Shell* ovate-elliptical, conoidal, height 0·39 of length. Right side straight in centre, then rather sharply turning to either end. Apex a little behind the centre, directed backwards and to the left. Anterior slope slightly arched, posterior nearly straight. Margin fairly regular and crenulated, chiefly on the right side. Siphonal groove not prominent. *Sculpture:* There are about 40 rounded smooth and polished radiating ribs. These are irregular in size, the larger ones being chiefly on the posterior slope, while there are 2 prominent ones on the siphonal groove. *Colour:* Bluish, darker towards the centre, the ribs nearly white, especially near the margin. Interior light-bluish, the margin nearly black, with white transverse bands opposite the ribs. At the siphonal groove 2 white bands extend about half-way towards the apex.

Length, 18 mm. Breadth, 12·8 mm. Height, 7 mm.

Variations from Type.—The ribs vary somewhat in prominence, and the general shape of the shell is liable to variation, as will be seen by the following measurements: (*a.*) Length, 19·6 mm.; breadth, 15·6 mm.; height, 6·4 mm.; ratio height to length (L. = 100), 0·31. (*b.*) Length, 19·8 mm.; breadth, 14·5 mm.; height, 7 mm.; ratio height to length, 0·28. (*c.*) Length, 17 mm.; breadth, 13 mm.; height, 7 mm.; ratio height to length, 0·24. The colour varies somewhat. The interior is sometimes nearly white or yellowish, with a black-banded margin. The apex is occasionally eroded and whitish. Most of my specimens were collected on rocks adjoining sandy beaches, and show the effects of sand-rubbing in their highly polished surfaces.

Habitat.—Living on rocks between tide-marks, Sunday Island; plentiful in places.

Siphonaria cheesemani n. sp. Figs. 41 and 41*a*.

Description of Type Specimen.—*Shell* elliptical, slightly narrowed in front, very depressed, height 0·21 of length, slopes nearly straight. Margin deeply incised, the principal ribs projecting to a distance equal to their width, slightly crenulated between the projecting ribs. Siphonal groove a double rib, but not more prominent or projecting further than the other large ribs. *Sculpture:* There are 13 high rounded radiating ridges, each projecting beyond the margin. The anterior ridges slightly smaller than the posterior. Ridges irregularly spaced, the largest interstice being behind the siphonal groove, the second-largest immediately posteriorly to this. Between the principal ribs are smaller riblets, chiefly noticeable on the right side. The whole upper surface covered with crustaceous algae, apex eroded. *Colour:* Interior nearly black, with a central white spot. Margin darker, with white bands opposite the ribs and riblets.

Length, 17·3 mm. Breadth between parallels touching the ribs, 13·5 mm. Height, 3·7 mm.

Variations from Type.—There being no adult specimens collected that were not covered with algae, I am obliged to add the following particulars from a smaller beach specimen: Apex situated behind and to the left of the centre and directed away from the centre. Between the principal ribs are fine close riblets. Concentric growth-lines show over the whole surface.

The number of principal ribs varies in different shells, being usually more than in the type, while the anterior ribs are frequently smaller and more numerous than in the type.

Habitat. — Abundant living on rocks near low-water mark, Sunday Island. The shells almost always covered with crustaceous algae, and sometimes found attached to shells of *Scutellastra kermadecensis*. In its depressed form it resembles a number of marine molluscs inhabiting the lowest portion of the littoral belt.

Siphonaria macauleyensis n. sp. Figs. 42 and 42*a*.

Description of Type Specimen.—Shell irregularly ovate, high, conical, height 0·48 of length. Anterior slope long, arched; posterior slope steep, nearly straight. Apex nearly two-thirds the length of the shell from the anterior end, and to the left of the central line, directed backwards. Margin fairly regularly crenulated. Siphonal groove scarcely projecting. *Sculpture:* About 45 close nearly regular radiating ribs, two on the siphonal groove and a few others here and there on the posterior half larger than the others. All crossed by concentric growth-lines. *Colour:* Above grey, the ribs nearly white. Interior whitish in the centre, muscle-impression brown, followed by a whitish band and a dark-brown margin crossed by white bands opposite the ribs.

Length, 19·6 mm. Breadth, 14·6 mm. Height, 9·5 mm.

Variations from Type.—There is a good amount of variation in the shape of the shell, prominence of the ribs, and especially of the siphonal groove, which sometimes projects a considerable distance. When this is the case with depressed forms they come very close to the subspecies *perplexa*. The depth of colour inside varies, some examples having the central portion all brown. The following measurements show variations in the shells: (*a*.) Length, 19·5 mm.; breadth, 16·2 mm.; height, 10 mm.; ratio height to length (L.=100), 0·51. (*b*.) Length, 19·3 mm.; breadth (behind siphonal groove), 15·5 mm.; height, 6·2 mm.; ratio height to length, 0·32.

A few specimens which I collected on French Rock apparently belong to this species. They are larger than those from Macauley Island, and all have the upper surface either corroded or covered by coralline algae, so that the sculpture is obscured. The general shape and the colour of the interior, however, agrees with Macauley Island specimens. Length, 23 mm.; breadth, 18·5 mm.; height, 8·3 mm.

S. macauleyensis comes very close to *S. exulorum* from Norfolk Island, differing principally in the more irregular shape and ribbing, and in the more posterior position of the apex. *S. zealandica* is also allied, but easily distinguishable from the above two.

Habitat.—Living on rocks between tide-marks, Macauley Island (type locality) and French Rock; common. A few specimens were also obtained on Sunday Island.

Subsp. **perplexa** n. subsp. Figs. 43 and 43*a*.

Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*S. atra*).

Description of Type Specimen.—Shell depressed, height 0·29 of length, ovate, left side slightly rounded in the centre, sloping sharply away at either end, right side semicircular. Apex subcentral. Slopes slightly arched. Margin irregularly crenulated. Siphonal groove high, angular, and projecting for a distance equal to one-third of that between margin and apex. *Sculpture:* Irregularly spaced straight or wavy radiating ribs, about 20 principal ones, including 2 on the siphonal groove. They are of various sizes, those on the left side and alternate ones on the posterior half

being larger than the others. There are smaller riblets in the interstices, including those on the siphonal groove and a wide space between it and the next posterior large rib. *Colour:* Above bluish-grey, the ribs nearly white. Apex corroded. Interior bluish-brown, the margin darker, and with numerous white cross-bands opposite the ribs.

Length, 17·3 mm. Breadth behind siphonal groove, 13·2 mm. Height, 5 mm.

The type specimen of this subspecies differs considerably from that of the typical subspecies, but intermediate forms which might be referable to either are common, so that I could not divide them satisfactorily into two groups, hence the present arrangement under one species. *S. cheesemani* also in some of its forms approaches the subspecies *perplexa*.

Habitat.—Living on rocks near low-water mark, Sunday Island.

Siphonaria amphibia n. sp. Fig. 44.

Description of Type Specimen.—*Shell* small, ovate, narrowed in front, conoidal, height 0·35 of length. Apex behind the centre, anterior slope slightly curved, posterior slope straight. Margin irregular, siphonal groove slightly projecting. *Sculpture:* The upper half of the shell corroded. Margin with about 25 scarcely raised radiating ribs. *Colour* brown, the ribs white. Interior black, the margin crossed by white bands opposite the ribs.

Length, 7·8 mm. Breadth, 6·2 mm. Height, 2·7 mm.

Variations from Type.—Most of the shells have the interior entirely black, and in many the entire upper surface is corroded.

Habitat.—This little species was found living in crevices and irregularities of rocks near high-water mark at Fleetwood Bluff, Sunday Island. In size, appearance, and habits it resembles some small species of *Acmaea* which occur in similar situations in New Zealand.

Gadinia conica Angas.

Gadinia conica Angas, Pro. Zool. Soc., 1867, 115, 1868.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Living on rocks between tide-marks, Sunday Island.
Distribution.—New Zealand, Australia.

Helicarion kermadecensis (Smith).

Vitrina kermadecensis E. A. Smith, Ann. Mag. Nat. Hist. (4), xi, 288, 1873.
Recorded, E. A. Smith, *l.c.*

Habitat.—Living on the under-surfaces of the leaves of the nikau palm (*Rhopalostylis Baueri*) on the summit of Moumoukai, the highest point of Sunday Island. Found only during wet weather, October, 1908. Also found living under dead leaves on the ground.

Ptychodon royanus Iredale.

Ptychodon royanus Iredale, Pro. Mal. Soc., x, 377, 1913.
Recorded, Iredale, *l.c.*

Habitat.—Living on the moss-covered trunks of trees, Sunday Island.

Ptychodon pseutes Iredale.

Ptychodon pseutes Iredale, Pro. Mal. Soc., x, 378, 1913.
Recorded, Iredale, *l.c.*

Habitat.—Living on the ground under stones, rotten wood, and dead palm-leaves, Sunday Island.

Ptychodon amandus Iredale.

Ptychodon amandus Iredale, Pro. Mal. Soc., x, 378, 1913.
Recorded, Iredale, *l.c.*

Habitat.—Living on the ground under stones, wood, and dead palm-leaves, Sunday Island.

Charopa macgillivrayana Iredale.

Charopa macgillivrayana Iredale, Pro. Mal. Soc., x, 379, 1913.
Recorded, Iredale, *l.c.*

Habitat.—Living on the ground under stones, wood, and leaves on high land only, Sunday Island.

Charopa exquisita Iredale.

Charopa exquisita Iredale, Pro. Mal. Soc., x, 379, 1913.
Recorded, Iredale, *l.c.*

Habitat.—Living on the ground under stones, wood, and leaves, Sunday Island.

Charopa pseudanguicula Iredale.

Charopa pseudanguicula Iredale, Pro. Mal. Soc., x, 380, 1913.
Recorded, Iredale, *l.c.*

Habitat.—Living on the moss-covered trunks of trees, Sunday Island.

Flammulina miserabilis Iredale.

Flammulina miserabilis Iredale, Pro. Mal. Soc., x, 383, 1913.
Recorded, Iredale, *l.c.*

Habitat.—Living on moss-covered trunks of trees, Sunday Island.

Paralaoma raoulensis Iredale.

Paralaoma raoulensis Iredale, Pro. Mal. Soc., x, 381, 1913.
Recorded, Iredale, *l.c.*

Iredale describes a second species of *Paralaoma* from Sunday Island. I have some hundreds of specimens, which, though the number of lamellae varies, can scarcely be separated into two definable groups. I therefore treat his species as subspecies, which, using his diagnoses, may be thus defined :—

Subsp. *typica.*—Periphery rounded, lamellae on last whorl usually exceeding 40.

Subsp. *ambigua* (Iredale).—Periphery semi-keeled, lamellae on last whorl usually less than 30.

Habitat.—Living on the ground under stones, rotten wood, and dead leaves, Sunday Island.

Calymna arboricola Iredale.

Calymna arboricola Iredale, Pro. Mal. Soc., x, 383, 1913.
Recorded, Iredale, *l.c.*

Habitat.—Living on moss-covered trunks of trees, Sunday Island.

Fanulum expositum (Mousson).

Trochonanina exposita Mousson, Journ. de Conch., xxi, 111, 1873.
Recorded, Mousson, *l.c.*

Var. *moumoumkai* Iredale. — Shell yellowish-white. Single specimens only found. Possibly these are albinos. I think they scarcely justify a name.

Habitat.—Living on the ground under rotten palm-leaves in scattered colonies on the higher ground only, Sunday Island.

Kieconcha kermadeci (Pfeiffer).

Helix kermandeci Pfeiffer, Pro. Zool. Soc., 1856, 326, 1857.
Recorded, Pfeiffer, *l.c.*

Habitat.—Living on the ground under rotten wood and palm-leaves. Found sporadically over the whole of Sunday Island.

Elasmias inconspicua (Brazier).

Tornatellina inconspicua Brazier, Pro. Zool. Soc., 1872, 619, 1873.
Recorded, Iredale, Pro. Mal. Soc., x, 386, 1913.

Habitat.—In Denham Bay, Sunday Island, living on a patch of kawakawa (*Macropiper excelsum*). Found during rain crawling on the stems and under-surfaces of the leaves.

Distribution.—Lord Howe Island.

Tornatellina novoseelandica (Pfeiffer).

Tornatellina novoseelandica Pfeiffer, Hel. Viv., iii, 524, 1853.
Recorded, Pfeiffer, 1863 (Iredale, Pro. Mal. Soc., x, 386, 1913).

Habitat.—Living on the trunks of trees and palms, Sunday Island.

Distribution.—New Zealand.

Tornatellina subperforata Suter.

Tornatellina subperforata Suter, Pro. Mal. Soc., viii, 263, 1909.
Recorded, Suter, *l.c.*

Habitat.—Living on the ground under stones, leaves, and wood, Sunday Island; extremely abundant. This is the species which Iredale (Pro. Mal. Soc., x, 364, and Trans. N.Z. Inst., 47, p. 481, *ante*) refers to *T. novoseelandica.*

Distribution.—New Zealand.

LAMELLIBRANCHIA.

Pronucula kermadecensis n. sp. Fig. 45.

Description of Type Specimen.—Shell small, very inequilateral, obliquely ovate, beaks at about the posterior fourth, directed backwards. Anterior end sloping, rounded in front, posterior end shortly rounded. Escutcheon indistinctly marked. Hinge with a triangular resilium directed forwards, a series of hinge-teeth on either side of the resilium, 8 anterior and 3 posterior, decreasing in size towards the apex. Adductor-scars scarcely impressed,

nearly equal, pallial line indistinct. *Sculpture:* There are regularly spaced low concentric riblets, variable in size, the larger ones being nearer the margin, crossed by fine close radiating striae. *Colour* yellowish-white.

Diameter—Dorso-ventral, 1·4 mm.; ant.-post., 1·8 mm.

Variations from Type.—Dead shells are white; epidermis on live shells thin, pale olive.

Habitat.—Live shells collected at Sunday Island by R. S. Bell.

Placunanomia zelandica (Gray).

Anomia zelandica Gray in Dieff. N.Z., 260, 1843.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*P. ione*).

Habitat.—Dead shells frequently washed up on the beaches, Sunday Island.

Distribution.—New Zealand, Australia.

Arca foliata Forskal.

Arca foliata Forskal, Descr. Anim., p. xxxi, 1775.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.

Fossil.—In course volcanic gravel cemented by calcite, Titi Knob, Sunday Island; and in hard sandy tuffs of submarine origin, Deyrell Islet. (*A. decussata* Oliver, Trans. N.Z. Inst., 43, 527.)

Distribution.—Australia, Indo-Pacific region.

Arca reticulata Gmelin.

Arca reticulata Gmelin, Syst. Nat., ed. xiii, 3311, 1790.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910 (*A. domingensis*).

Habitat.—Living specimens found attached to the underside of stones in rock-pools, Sunday Island and Meyer Island.

Distribution.—New Zealand, Tasmania, Australia, Japan, Atlantic coasts, Funafuti, Lord Howe Island, Norfolk Island.

Philobrya costata (Bernhard).

Hochstetteria costata Bernhard, Bull. d. Nat. Mus., ii, 1896.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Single valves common in dredgings in 10 m. to 30 m. off Sunday Island. Colour varying from dark pink to white.

Distribution.—New Zealand.

Philobrya meleagrina (Bernhard).

Hochstetteria meleagrina Bernhard, Bull. d. Nat. Mus., ii, 1896.

Habitat.—Extremely abundant living among the densely growing alga *Pterocladia capillacea* on rocks about and below low-water mark, Sunday Island.

Distribution.—New Zealand.

Mytilus canaliculus Martyn.

Mytilus canaliculus Martyn, Univ. Conch., ii, fig. 78, 1784.
Recorded, Suter, Man. N.Z. Moll., 864, 1913.

Distribution.—New Zealand, Tasmania.

Modiolus auriculatus Krauss.

Modiolus auriculatus Krauss, Sudafrik. Moll., 20, 1848.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Living in rock-pools and crevices of rocks at low-water mark (not common), Sunday Island.

Distribution.—Lord Howe Island, Norfolk Island, Australia, Indian Ocean.

Lithophaga straminea (Dunker).

Lithodomus straminea Dunker, Reeve, Conch. Icon., x, fig. 11, 1858.
Recorded, Iredale, Pro. Mal. Soc., ix, 71, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.

Distribution.—Australia, Indo-Pacific region.

Septifer bilocularis (Linné).

Mytilus bilocularis Linné, Syst. Nat., ed. x, 705, 1758.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—Living among the alga *Corallina officinalis* in rock-pools between tide-marks, Sunday Island.

Distribution.—Australia, Indo-Pacific region.

Musculus impacta (Hermann).

Mytilus impactus Hermann, Naturforscher, xvii, pl. 3, figs. 5–8, 178, 1782.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910 (*Modiolaria*).

Habitat.—Dead shells found on the beaches, Sunday Island.

Distribution.—New Zealand, Australia.

Pinclada vulgaris (Schum.).

Perlamater vulgaris Schumacher, Essai, 108, 1817.
Recorded, Suter, Trans. N.Z. Inst., 38, 316, 1906 (*Meleagrina radiata*).

Habitat.—Small live specimens found in rock-pools between tide-marks, Sunday Island.

Distribution.—Lord Howe Island, Norfolk Island, Indo-Pacific region.

Melina nucleus (Lamarck).

Perna nucleus Lam., Anim. s. Vert., vii, 78, 1836.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—Living in crevices of rocks between tide-marks, Sunday Island.

Distribution.—Indo-Pacific region.

Malleus legumen Reeve.

Malleus legumen Reeve, Conch. Icon., xi, pl. 1, fig. 2, 1858.

Specimens from the Kermadec Islands are in Mr. Suter's collection.

Distribution.—Australia, Malaya.

Julia exquisita Gould.

Julia exquisita Gould, Pro. Bost. Soc. N.H., viii, 284, 1862.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—Single valves of this beautiful little shell occurred rarely in dredgings in 10 m. to 30 m. on gravelly bottom near Sunday Island.

Distribution.—Queensland, Hawaii, Indian Ocean.

Spondylus raoulensis n. sp. Fig. 49.

Description of Type Specimen.—Right valve attached to rock, irregular, very deep at apex. Hinge-line straight, sides expanding at first gradually then suddenly, forming a nearly circular outline. Planes of hinge area and margin at right angles, contour of margin viewed laterally convex. Hinge area triangular, slightly concave, sides sinuous. Hinge-teeth projecting, with a deep cartilage-pit between them. *Sculpture:* Hinge area smooth, surface in contact with rock rough and irregular, otherwise with indistinct radiating ribs and concentric growth-lines. *Colour* pink; purplish on the angles of the hinge area; apex and hinge area mostly white.

Diameter—Dorso-ventral, 63 mm.; ant.-post., 54 mm. Hinge area—Base, 30 mm.; height, 27 mm.

Left valve (of another specimen) irregular, shallow. Cartilage-pit narrow, triangular, formed by two raised ridges on hinge-plate converging at apex. Hinge-teeth high, rounded, their dorsal face overhanging a marginal groove. *Sculpture:* There are 12 prominent but irregular radiating ridges, of which 6 high ones alternate with 6 lower ones. The interspaces with close, wavy, lamellated, radiating ribs, slightly irregular in size. *Colour* pink, darker on the ridges and ears.

Diameter Dorso-ventral, 73 mm.; ant.-post., 72 mm.

Variations from Type.—Large shells are massive and heavy. The angle of the planes of hinge area and margin increase with age. The colour varies, some shells being entirely purplish, others with much yellowish diffused with pink, but the ears and angles of the hinge area are usually purplish. Large right valve: Diameter—dorso-ventral, 125 mm.; ant.-post., 98 mm. Angle of planes of hinge area and margins, 135°. The hinge area varies in outline, and the apex points either forward or backward. Young specimens have spines on the ridges; these are probably worn off the types, which are beach specimens.

Habitat.—Single valves, often of large size, commonly washed up on the beaches, Sunday Island. A fragment of pumicestone with a small live shell attached was dredged in 25 m. off Sunday Island by R. S. Bell.

Fossil.—Common in hard sandy tuffs of submarine origin, Deyrell Islet. (*S. ostreoides* Oliver, Trans. N.Z. Inst., 43, 527.)

Spondylus ostreoides E. A. Smith.

Spondylus ostreoides E. A. Smith, "Challenger" Rep., xiii, pt. 35, 326, 1885.

Recorded, E. A. Smith, *l.c.*

Habitat.—Two single valves dredged in 950 m. south of Sunday Island ("Challenger" Expedition).

Cyclopecten kermadecensis (E. A. Smith).

Pecten kermadecensis E. A. Smith, "Challenger" Rep., xiii, pt. 35, 302, 1885.

Recorded, E. A. Smith, *l.c.*

Habitat.—Two valves dredged in 1,100 m. north of Sunday Island on hard ground ("Challenger" Expedition).

Pecten medius Lamarck.

Pecten medius Lamarck, Anim. s. Vert., vi, 163, 1819.

Habitat.—Dredged alive in 30 m. off Meyer Island (W. S. Bell).

Distribution.—New Zealand, Tasmania, Australia.

Chlamys cellularis' n. sp. Fig. 46.

Description of Type Specimen.—Left valve triangularly orbicular, flatly rounded. Anterior ear one-third the length of the shell, triangular, its outer edge sinuous, a shallow groove and sinus at its inner margin. Posterior ear narrowly triangular. Disc with the dorsal margins sharply descending, very slightly concave; rounded and descending somewhat along the anterior, basal, and posterior margins, which are slightly crenulate. Resilifer obliquely triangular. The epidermis usually persists, especially in the interstices between the ribs, as a cellular covering, giving the shell a characteristic honeycomb appearance. *Sculpture:* Anterior ear with 6 radiating ribs, the 3 outer ones broad and flattened, the 3 inner ones about half the width of the outer. Posterior ear with small radiating ribs. Disc with 15 principal radiating ribs, the 2 central ones are smaller than the others. The upper surface of the ribs divided by 2 grooves into 3 riblets, of which the central one is largest. In the interstices are 2 riblets in the angles at the bases of the principal ribs, leaving a wide and deep channel in the centre, and grooves the width of the riblets between them and the principal ribs. The surface of the shell presents a microscopically reticulated appearance, apparently due to the growth of the epidermal covering. The marginal portion of the riblets has a series of projecting shelly scales. Interior prominently grooved. *Colour* white, diffused with pink, chiefly on the ribs, and as 3 concentric broad bands on the upper portion of the disc. Base of ears with pink blotches.

Diameter—Ant.-post., 18·5 mm.; dorso-ventral, 20·2 mm.

Variations from Type.—Right valve with the anterior ear oblong, obliquely truncated, a deep byssal sinus below; posterior ear narrowly triangular. The colour is variable. The irregular pink markings are present on all the specimens seen, and are arranged in more or less defined concentric bands. The ground-colour on one shell is lemon-yellow.

Habitat.—The only specimens obtained were single valves found on the beaches at Sunday Island.

Fossil.—A valve apparently referable to this species was found on Deyrell Islet in hard sandy tuffs of submarine origin. (*Pecten kermadecensis* Oliver, Trans. N.Z. Inst., 43, 527, 1911.)

Limatula bullata (Born).

Ostrea bullata Born, Mus. Caes. Vindobin, 110, 1780.

Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910 (*Lima*).

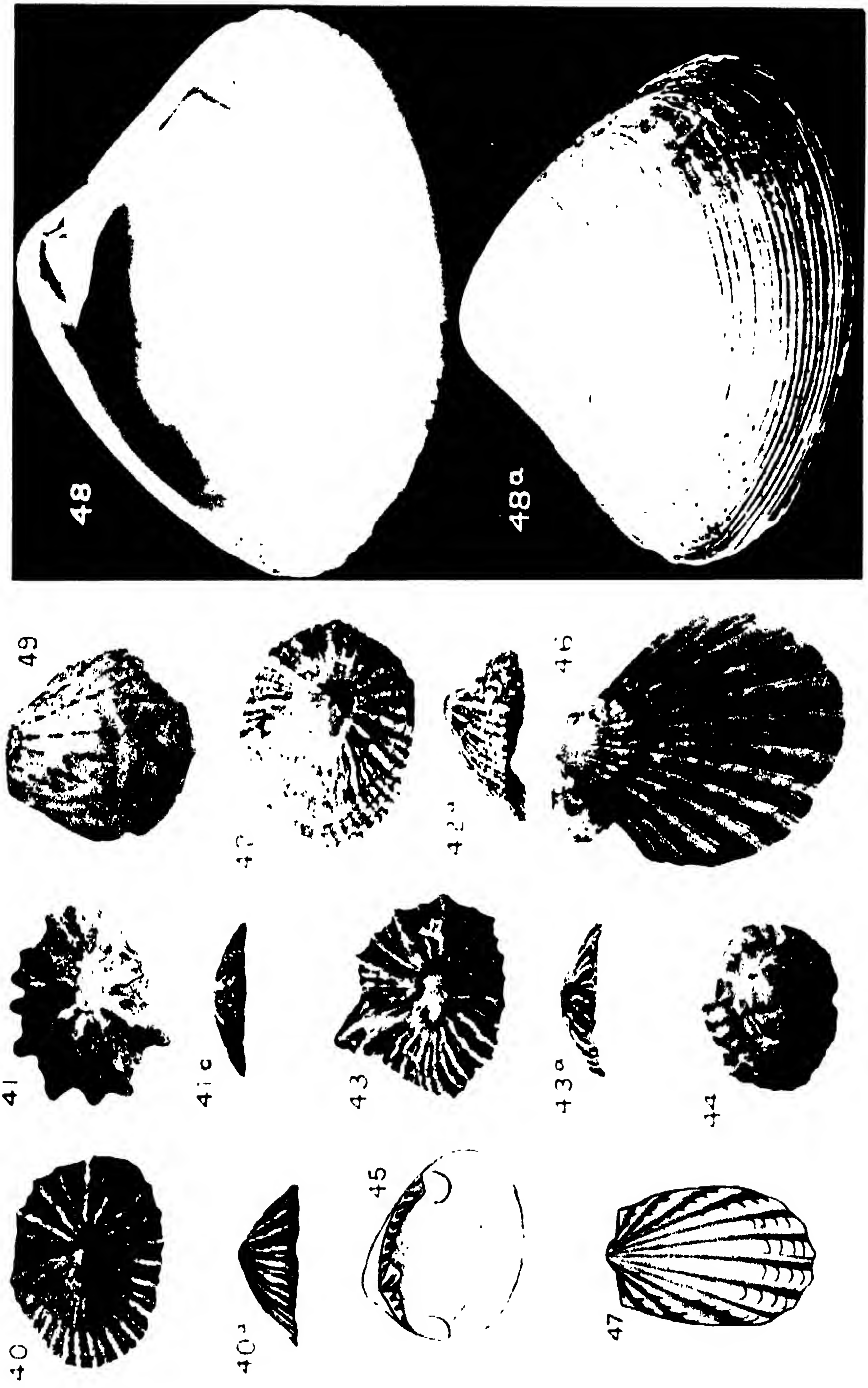
Habitat.—Valves common in dredgings in 10 m. to 30 m. near Sunday Island.

Distribution.—New Zealand, Tasmania, Australia, Pacific, Philippines.

Limatula insularis n. sp. Fig. 47.

Description of Type Specimen.—Shell ovate-oblong, very slightly oblique, ventricose, posterior end slightly more convex than anterior end. Beaks incurved, distant. Ears small, nearly equal. Hinge area straight, lenticular. *Sculpture:* On each valve are 12 rounded radiating ribs, the interstices and ribs about equal in width. These are crossed by close concentric growth-lines, and, near the margins, projecting shelly scales, most prominent at the posterior and anterior ends. *Colour* white.

Diameter — Ant.-post., 2·3 mm.; dorso-ventral, 3·5 mm. Thickness, 2·1 mm.



Face p. 664.]

Variations from Type.—The number of ribs varies a little, and may be as high as 15 on each valve. The largest specimen collected measures 3 mm. by 4·4 mm.

Habitat.—Dredged alive near Sunday Island (R. S. Bell).

Codakia bella (Conrad).

Lucina bella Conrad, Journ. Acad. Sci. Phila., vii, 254, 1834.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—Live specimens fairly plentiful in sand in rock-pools, Meyer Island.

Distribution.—Australia, Indo-Pacific region.

Diplodonta zelandica (Gray).

Lucina zelandica Gray in Yate's N.Z., 309, 1835.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.

Distribution.—New Zealand, Tasmania, Australia.

Lasaea miliaris Philippi.

Lasaea miliaris Philippi, Wiegman's Archiv. f. Natur., 51, 1845.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—Extremely abundant living among the alga *Corallina officinalis* on rocks between tide-marks, Sunday Island.

Distribution.—New Zealand, Lord Howe Island, North Atlantic, Cape of Good Hope, Magellan Straits.

Ervilia bisculpta Gould.

Ervilia bisculpta Gould, Pro. Bost. Soc. N.H., viii, 28, 1861.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.

Distribution.—Australia, Hawaii, Japan, Philippines.

Spisula belliana n. sp. Figs. 48 and 48*a*.

Description of Type Specimen.—Left valve large, solid, somewhat ventricose, trigonal, slightly inequilateral. Posterior dorsal margin arched, anterior straight. Basal margin regularly arched. Anterior and posterior ends subangulated. Posterior dorsal area flattened and laterally bluntly angled. Lunular area lenticular, well defined. Beak incurved, acute. Hinge: Cardinal bifurcating below, lateral laminae high, stout, depression between cardinal and anterior lateral deep. Resilifer obliquely triangular, apex acute. Ligament very short. Adductor-scars deeply impressed, anterior the smaller. Pallial sinus extending about half-way to the anterior adductor, posteriorly coalescent with the pallial line. Epidermis thin, horny. *Sculpture:* There are regular smooth concentric riblets, most prominent at the margins (the apical region is worn smooth and without epidermis). *Colour* white; epidermis yellow with reddish-brown spots.

Diameter—Dorso-ventral, 64 mm.; ant.-post., 83 mm.; transverse (to plane of margin), 17 mm.

Variation from Type.—Right valve with 2 small cardinals coalescing above, 2 anterior and 2 posterior lamellae, the anterior the longer.

Habitat.—Two valves found washed up on the beaches, Sunday Island (R. S. Bell).

Chione toreuma (Gould).

Venus toreuma Gould, Pro. Bost. Soc. N.H., iv, 277, 1850.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—Single valves occasionally washed up on the beaches at Sunday Island.

Fossil.—In volcanic gravel cemented by calcite, Titi Knob, Sunday Island. (*Chione* sp. Oliver, Trans. N.Z. Inst., 43, 530.)

Distribution.—Australia, Pacific Ocean.

Lutraria magna (Costa).

Chama magna Costa, Brit. Conch, 230, 1778.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910 (*L. oblonga*).

Habitat.—Valves dredged near Sunday Island.

Distribution.—Australia, Indo-Pacific region.

Protocardia pulchella (Gray).

Cardium pulchellum Gray in Dieff. N.Z., 252, 1843.

Habitat.—Dredged in 30 m. off Meyer Island (W. S. Bell).

Distribution.—New Zealand, Tasmania, Australia, Norfolk Island.

Chama foliacea Quoy and Gaimard.

Chama foliacea Q. & G., Voy. "Astrolabe," Zool., iii, 478, 1835.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—Single valves occasionally washed up on the beaches at Sunday Island.

Distribution.—Lord Howe Island, Indo-Pacific region.

Saxicava artica (Linné).

Mya arctica Linné, Syst. Nat., ed. xii, 1113, 1767.
Recorded, Suter, Subantarctic Is. N.Z., i, 48, 1909.

Habitat.—Specimens taken from logs washed up on the beaches at Sunday Island.

Distribution.—New Zealand, Australia, cosmopolitan.

Gastrochaena retzii Deshayes.

Gastrochaena retzii Deshayes, Moll. de Réunion, 7, 1863.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—Dead shells found on the beaches, Sunday Island.

Distribution.—Indo-Pacific region.

Uperotis clava (Gmelin).

Teredo clava Gmelin, Syst. Nat., ed. xiii, 3748, 1791.

Habitat.—Colonies attached to coconuts found washed up on the beaches, Sunday Island.

Distribution.—Indo-Pacific region.

Nausitoria aurita Hedley.

Nausitoria aurita Hedley, Mem. Austr. Mus., iii, 507, 1899.

Habitat.—Plentiful in kauri (*Agathis australis*) logs washed up on the beaches at Sunday Island.

Distribution.—New Caledonia, Funafuti.

AMPHINEURA.

Lepidopleurus subtropicalis Iredale.

Lepidopleurus (*Terenochiton*) *subtropicalis* Iredale, Pro. Mal. Soc., xi, 28, 1914.

Recorded, Iredale, *l.c.*

Habitat.—Living on the underside of embedded dirty stones near low-water mark, Coral Bay, Sunday Island.

Parachiton mestayerae Iredale.

Parachiton mestayerae Iredale, Pro. Mal. Soc., xi, 27, 1914.

Recorded, Iredale, *l.c.*

Habitat.—Dredged on gravelly bottom near Sunday Island in 27 m. and 45 m. (Iredale); also living on underside of stones near low-water mark, Coral Bay.

Ischnochiton kermadecensis Iredale.

Ischnochiton kermadecensis Iredale, Pro. Mal. Soc., xi, 35, 1914.

Recorded, Iredale, *l.c.*

This species is closely allied to *I. intermedius* Hedley and Hull, from Norfolk Island. Iredale also describes a colour-variety under the name *exquisita.*

Habitat.—Abundant living on the underside of clean smooth stones near low-water mark, Sunday Island and Meyer Island.

Eudoxochiton perplexus Iredale.

Eudoxochiton perplexus Iredale, Pro. Mal. Soc., xi, 29, 1914.

Recorded, Iredale, *l.c.*

This species varies considerably in the angle of divergence of the median valves, and also slightly in the number of slits in the posterior valves. Using these characters, Iredale separated the Kermadec shells into two species; but as intermediate forms are the rule, and no satisfactory line can be drawn between the extreme forms, I consider the proper course is to treat them as one species. Utilizing the above characters, it is perhaps convenient to refer to Iredale's groups as varieties, which may be thus defined.

Var. *typica.*—Shell elevated, anterior and posterior valves each with about 23 slits.

Var. *imitator* (Iredale).—Shell depressed, anterior valve with more than 25 slits, posterior valve with about 22 slits.

Habitat.—Living on rocks about low-tide mark, Sunday and Meyer Islands. During the winter strong westerly winds caused the shifting of a good deal of sand on the north side of Sunday Island; this partly buried the lower portions of a rocky coast, and drove numbers of marine animals, including *Eudoxochiton* inshore, so that as many as sixteen of this species were captured in a single day.

Plaxiphora mixta Iredale.

Plaxiphora (*Maorichiton*) *mixta* Iredale, Pro. Mal. Soc., xi, 33, 1914.

Recorded, Iredale, *l.c.*

Habitat.—Living on rocks between tide-marks (fairly common), Sunday, Meyer, and Macauley Islands, and French Rock.

Rhyssoplax corypheus (Hedley and Hull).

Chiton corypheus Hedley and Hull, Pro. Linn. Soc. N.S.W., 37, 277, 1912.

Recorded, Iredale, Pro. Mal. Soc., xi, 41, 1914 (*Rhyssoplax exasperata*).

Here again I consider Iredale has overestimated the value of the distinguishing characters of the Kermadec Chitons. There is no good character by which the Norfolk and Sunday Island shells can be differentiated, but, recognizing the differences pointed out by Iredale, the Kermadec form may (as suggested by him) be ranked as a subspecies of *corypheus*, thus:—

Subsp. *exasperata* (Iredale).—Differs from the type in having the sulci weaker and less nodulous.

Habitat.—Living on the underside of clean smooth stones near low-tide mark, Sunday Island.

Distribution (of species).—Norfolk Island.

Sympharochiton themeropis Iredale.

Sympharochiton themeropis Iredale, Pro. Mal. Soc., xi, 43, 1914.
Recorded, Iredale, *l.c.*

Habitat.—Living in crevices of rocks between tide-marks, Meyer Island.

Onithochiton oliveri Iredale.

Onithochiton oliveri Iredale, Pro. Mal. Soc., xi, 46, 1914.
Recorded, Iredale, *l.c.*

Closely allied to *O. filholi* Roch, of New Zealand.

Habitat.—Living in crevices of rocks between tide-marks, Meyer Island; not common.

CEPHALOPODA.

Nautilus pompilius Linné.

Nautilus pompilius Linné, Syst. Nat., ed. x, 708, 1758.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—Broken shell washed up on beach, Sunday Island.

Distribution.—Australia, New Hebrides, Fiji, Polynesia.

Nautilus macromphalus Sowerby.

Nautilus macromphalus Sowb., Thes. Conch., 464, 1848.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—Broken shell washed up on beach, Sunday Island.

Distribution.—New Caledonia.

Spirula spirula (Linné).

Nautilus spirula Linné, Syst. Nat., ed. x, 710, 1758.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—Dead shells washed up on the beaches, Sunday Island, often in large numbers. Portions of the animal were also found.

Distribution.—Lord Howe Island, New Zealand, tropics generally.

Symplectoteuthis oualaniensis (Lesson).

Loligo oualaniensis Lesson, Voy. "Coquille," Zool., ii, 240, 1830.
Recorded, Berry, Trans. N.Z. Inst., 46, 148, 1914.

Habitat.—Rarely washed up on the beaches, Sunday Island

Distribution.—Australia, Indian and Pacific Oceans.

Sthenoteuthis bartramii (Lesueur).

Loligo bartramii Lesueur, Journ. Acad. Nat. Sci. Phila., ii, 90, 1821.
Recorded, Berry, Trans. N.Z. Inst., 46, 148, 1914.

Habitat.—Specimens occasionally washed up on the beaches, Sunday Island.

Distribution.—Atlantic Ocean.

Onychoteuthis banksii (Leach).

Loligo banksii Leach, Zool. Mis., iii, 141, 1817.
Recorded, Berry, Trans. N.Z. Inst., 46, 139, 1914.

Habitat.—Rarely washed up on the beaches, Sunday Island.

Distribution.—Lord Howe Island (Etheridge), cosmopolitan.

Abralia astrolineata Berry.

Abralia astrolineata Berry, Trans. N.Z. Inst., 46, 145, 1914.
Recorded, Berry, *l.c.*

Habitat.—One specimen washed up on beach, Sunday Island.

Abraliopsis hoylei (Pfeiffer).

Enoploteuthis hoylei Pfeiffer, Abh. Nat. Virens. Hamb., viii, 17, 1884.
Recorded, Berry, Trans. N.Z. Inst., 46, 148, 1914.

Habitat.—One young specimen found on the beach, Sunday Island.

Distribution.—Mascarene Islands, Pacific coast, middle America.

Nematolampas regalis Berry.

Nematolampas regalis Berry, Biol. Bull., xxv, 208, 1913.
Recorded, Berry, *l.c.*

Habitat.—Two specimens found on the beach, Sunday Island.

Cirroteuthis meangensis Hoyle.

Cirroteuthis meangensis Hoyle, Ann. Mag. Nat. Hist. (5), xv, 234, 1885.
Recorded, Hoyle, " Challenger " Rep., xvi, pt. 44, 104, 1886.

Habitat.—Dredged in 1,100 m. on hard ground north of Sunday Island (" Challenger " Expedition).

Distribution.—Meangis Islands (near Philippines).

Amphitretus pelagicus Hoyle.

Amphitretus pelagicus Hoyle, Ann. Mag. Nat. Hist. (5), xv, 235, 1885.
Recorded, Hoyle, *l.c.*

Habitat.—Dredged in 950 m. on volcanic mud between Sunday and Macauley Islands (" Challenger " Expedition).

Eledone verrucosa Verril.

Eledone verrucosa Verril, " Blake " Report, 105, 1881.
Recorded, Hoyle, " Challenger " Rep., xvi, pt. 44, 104, 1886.

Habitat.—Dredged in 1,150 m. on volcanic mud between Sunday and Macauley Islands (" Challenger " Expedition).

Distribution.—North Atlantic.

Pinnoctopus kermadecensis Berry.

Polypus (*Pinnoctopus ?*) *kermadecensis* Berry, Trans. N.Z. Inst., 46, 138, 1914.
Recorded, Berry, *l.c.*

Habitat.—One specimen found on beach, Sunday Island.

Polypus oliveri Berry.

Polypus oliveri Berry, Trans. N.Z. Inst., 46, 136, 1914.
Recorded, Berry, *l.c.*

Habitat.—Living among rocks between tide-marks, Sunday Island.

Argonauta argo Linné.

Argonauta argo Linné, Syst. Nat., ed. x, 708, 1758.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—A few shells washed up on the beaches, Sunday Island.
Distribution.—New Zealand, Atlantic, Indian, and Pacific Oceans.

Argonauta nodosa Solander.

Argonauta nodosa Sol., Portl. Cat., 96, 1786.
Recorded, Iredale, Pro. Mal. Soc., ix, 72, 1910.

Habitat.—Both animals and shells occasionally washed up on the beaches, Sunday Island. The description by Berry of a female (Trans. N.Z. Inst., 46, 135) probably refers to this species. The largest shell collected at Sunday Island measured 17 cm. in length, and when cast ashore contained the animal.
Distribution.—New Zealand, Atlantic, Indian, and Pacific Oceans.

Geographical Relationships.

Continuous with the orographical axis of New Zealand a submarine ridge with a steep eastern slope falling to one of the profoundest troughs of the ocean extends in a direction about N. 22° E. as far as the Samoan Islands, though actually separated from the elevated area on which that group stands by a channel over 4,000 m. in depth. This ridge over the greater part of its length is less than 2,000 m., and is nowhere over 4,000 m., beneath the surface of the ocean. It is on this ridge, about midway between New Zealand and the Tongan Islands, that the Kermadec Group is situated. To the eastward is an unbroken expanse of ocean over 4,000 m. in depth; to the westward an area of ocean stretching to the Australian Continent, and whose bed is most irregular, the main features being two basins separated by a submarine ridge trending in a direction north-west from New Zealand towards New Caledonia. The Kermadec Group, therefore, appears to be situated on the eastern edge of a bygone complex continental area now for the most part submerged.

In order correctly to understand the geographical relationships and origin of a fauna it is necessary first to investigate the history of the region from a dynamical standpoint, for conclusions as to past changes in land surfaces based on considerations of faunal relationships must be revised if they conflict with results derived from geological evidence. In the case of the Kermadec Group I have elsewhere* described the structure of the various

* Trans. N.Z. Inst., vol. 43, p. 525, 1911.

islands, and outlined their probable history. Briefly, my conclusions are these: All the islands are of recent volcanic formation, two of them being still in the solfatara stage. Sunday Island is built on a base of which part is known to be composed of syenite, a rock usually associated with continental areas. The first eruptions were submarine, the later ones subaerial. Sunday Island has thus arisen from beneath the sea in recent geological times, and has not exceeded its present limits more than can be accounted for by marine and subaerial denudation. Whatever portion of the continental base was ever formerly above sea-level was entirely submerged before the present group of islands came into existence, and any terrestrial life it may have contained completely destroyed. Assuming that I have interpreted the geological evidence correctly, then the whole of the terrestrial life now found at the Kermadecs has arrived by accidental transoceanic migration; but among its marine forms one might expect to find an element suggestive of a continental connection.

Owing to the vast amount of work still to be done on the *Mollusca* it is not possible to speculate on their origin and relationships except by a statistical method. The relationships of the 261 species enumerated in the present paper may be expressed in tabular form thus:—

——	Total.	Per Cent.	Gastropoda.	Lamellibranchia.	Amphineura.	Cephalopoda.
Endemic ..	89	34	70	7	8	4
Polynesian ..	108	42	89	19	..	..
New Zealand ..	31	12	22	9	..	..
Pelagic ..	33	12	21	..	..	12
	261	100	202	35	8	16

Endemic Element.

A third of the Kermadec molluscs are not known elsewhere. This proportion will probably be decreased when the molluscan fauna of the south-west Pacific is more closely studied. Taking first the *Gastropoda*, the bulk are probably of Polynesian affinities. Half the species are small shells, mostly under 5 mm. in length, most of them falling within the families *Rissoidae*, *Cerithiidae*, *Eulimidae*, and *Turritidae*. About one-fifth are fairly large shells, and these form a very remarkable collection of species which one might hardly expect on an isolated volcanic island. Possibly they indicate a former continental connection. Some of them appear to have no closely related species in the adjacent regions, though their affinities are mainly with the north (*Scutellastra kermadecensis*, *Tectus royanus*, *Conus kermadecensis*, *Cassidea royana*, *Spondylus raoulensis*). The highly variable members of the genera *Cellana* and *Siphonaria* were apparently derived from the south. The land shells are, according to Iredale, almost entirely of Polynesian origin.

Members of the class *Amphineura* appear to be particularly useful for indicating the routes of migration of marine faunas, especially as they are peculiarly sedentary in their habits, and, no doubt as a consequence, restricted in their distribution. The affinities of the Kermadec species are, as noted by Iredale, entirely with those of New Zealand. The presence of a variable member of the characteristic New Zealand genus *Eudoxochiton* is worthy of special notice.

Polynesian Element.

This is undoubtedly the largest element in the molluscan fauna of the Kermadecs. The figures given above include several species which I have in the literature at my disposal found recorded from Australia only; but most of them are tropical species, and no doubt extend to Polynesia as well. According to the table, over two-fifths of the Kermadec *Mollusca* are also found in Polynesia. But to estimate this element correctly there should be included all those endemic species of Polynesian affinities, and this would bring the proportion up to about two-thirds.

New Zealand Element.

Under this head I include one-eighth of the total number of molluscs known from the Kermadecs. Of these, twenty-three extend also to Australia, and, in addition, there are fifteen other New Zealand species distributed over the headings "Pelagic" and "Polynesian," thus making forty-six species common to the Kermadecs and New Zealand.

Pelagic Molluscs.

These are species which frequent the surface of the open ocean. They form about one-eighth of the total known molluscan fauna of the Kermadecs, a proportion which is evidently due to the situation of the group in a wide tract of ocean. Included are several Cephalopods and Pteropods, *Recluzia*, *Atlanta*, and four species of *Ianthina*, besides some species found in floating logs and coconuts.

Summary.

The *Mollusca* of the Kermadec Islands appear to be derived from two sources; that is, there appear to have been two main streams of migration—one, by far the larger, from Polynesia, and another from New Zealand. A highly peculiar group, typified by *Scutellastra kermadecensis*, may be taken as evidence of a first period of dispersal along a continental shore-line, but the bulk of the species, including all the terrestrial forms, indicate a later period synchronous with the existence of the present islands when no connection existed with other lands.

Ecology.

Although one of the most interesting branches of biological study, very little can be written under this head. A few remarks on the dependence of marine animals on the supply of water and food, quite obvious to the casual observer, interspersed among brief descriptions of the molluscan formations is all that I will attempt. These formations may conveniently be arranged, at least for my present purpose, in four series—namely, land, littoral rocks, sea-bottom, and surface of ocean. In abstracting the molluscan element in a formation, or, as I would prefer to call it, "biological community," one cannot get a correct view of the inter-relations of organisms, because the whole community really consists of every plant and animal living in and responding directly or indirectly—that is, through other plants or animals—to the same habitat. Defined by such considerations, two or more formations may be found in the same area. For instance, in the littoral belt, the group of organisms found living under stones is quite distinct from that found on their upper surfaces. The habitats are different, and few species are common to both.

Land Formations.

The numerous small animals and fungi living under stones and leaves in forest, and subsisting mainly on decaying vegetation, constitute a biological community distinct from but coterminous with the forest formation which gives rise to it. On Sunday Island eight small molluscs are found in this situation. On the trunks of trees eight other species are found; but this habitat is practically an extension of that on the ground, one species (*Helicarion kermadecensis*) being found in both. All the land molluscs found at Sunday Island are small, but this is, no doubt, due to the means of transportation available for them to reach the group—namely, on floating logs or other accidental means.

One land mollusc, *Assiminea nitida*, affected open rocks wetted by fresh water, which habitat was also shared by some crustaceans and cryptogamic plants.

Littoral Rock Formations.

Several communities of plants (algae) and animals are to be distinguished in the marine littoral belt. Certain ecological adaptations are easily observed when the whole belt is examined. For instance, the size of animals is found to increase from high-water mark downwards. In other words, the more water any station receives during the day, the greater the variety and abundance of life found therein; consequently, more food is available, and therefore larger animals are found. A second and more important though scarcely less obvious generalization is that the higher up above low-water mark an animal lives the more it is protected from desiccation by a calcareous shell or chitinous test. In the Kermadec Group rocks between tide-marks support a fauna and flora much poorer in species and individuals than the corresponding belt in New Zealand, and this I presume to be the result of its greater degree of insolation. In New Zealand I have observed that the line between the submerged and emerging belts is much more pronounced in the north than it is in the south.

Rock Belt.—Rocks about and above half-tide mark support no algae except crustaceous species, and in places small filamentous species, which, by harbouring mud, form a kind of slime. Molluscs, however, are fairly numerous. Near high-water mark are small species hiding in crevices of rocks, as *Melarhaphe unifasciata*, *Tectarius feejeensis*, *Siphonaria amphibia*—all able to live for more than half their time out of water. The *Siphonaria* by sticking close to the rock retains a drop of water, while *Tectarius* and *Melarhaphe* when withdrawn within their opercula are capable of living without water for days.

Lower down, where the rocks are exposed from about six to fifteen hours daily, are found plentifully *Cellana craticulatus*, *C. hedleyi*, *Siphonaria raoulensis*, *Neothais smithii*, *Plaxiphora mixta*, *Nerita melanotragus*, *Hinea brasilianus*, and less commonly *Pinclada vulgaris*, *Melina nucleus*, *Sympharochiton themeropis*, *Onithochiton oliveri*, and *Nerita plicata*—all able to conserve moisture by pressing close to the rock surface, or withdrawing within opercula or shelly valves.

Corallina Belt.—On rocks just above low-water mark considerable areas are covered by a dense growth, about 15 mm. tall, of the alga *Corallina officinalis*. This harbours, besides much sand and many worms, a large number of small bivalves of the species *Lasaea miliaris* and *Septifer bilocularis*.

Sargassum Belt.—The lowest tract of the emerging belt being exposed only at low spring tides, and constantly bathed by wave-action, is included in the belt of large brown algae extending to 1 m. or more below low-tide mark. This rocky belt, having a maximum quantity of light, supports a rich fauna and flora of a distinctly hydrophilous character. A number of large molluscs in no way protected against desiccation are found here. Such are *Polypus oliveri*, *Umbraculum umbella*, and many Aplysioids; to which should be added those molluscs which cannot draw into their shell behind an operculum, as *Conus kermadecensis*, *Siphonaria cheesemani*, and *Cypraea*. The large limpet *Scutellastra kermadecensis*, which must require a constant supply of food, is characteristic of this belt, in places almost covering the rocks. Its massive shell is rather a protection against predacious fishes than desiccation. Other large species found in this belt are *Charonia lampas*, *Argobuccinum australasia*, *Neothais succincta*, *Eudoxochiton perplexus*, and occasionally *Tectus royanus*. The dominant algae are *Sargassum fissifolium* and *Pterocladia capillacea*, the latter supporting in great abundance the small bivalve *Philobrya meleagrina*.

Under Stones.—With light absent or weak, and the presence of mud and sand, this habitat supports a distinctive fauna, composed of sponges, sea-anemones, worms, echinoderms, and molluscs. No algae were collected on the underside of rocks, except near the edges. The molluscs include four species of *Amphineura*, some small Gastropods (*Columbella versicolor*, *Gadinea conica*, *Vanikoro wallacei*, *Rissoina angasi*, *Clanculus atypicus*, and others), and the bivalves *Arca reticulata* and *Codakia bella*.

Sea-bottom.

Rocks near Shore.—In this belt, which extends from the *Sargassum* belt down for a few fathoms, the dominant fixed animals are corals and compound Ascidians. This is a difficult tract to investigate, as a dredge cannot be used. It is extremely rich in many kinds of animal life, and through a water-telescope presents a magnificent sight. *Tectus royanus* is abundant, while on coral *Magilus antiquus* and *Quoyula madreporarium* are plentiful. There can be little doubt that the large number of species of shells recorded in this paper as dredged on gravelly bottom and as found washed up on the beaches live among rocks below low-water mark.

Sand and Gravel.—A few live shells were dredged near Sunday Island on sand and gravel in 10 m. to 30 m. They include *Xenophora corrugata*, *Fusinus toreuma*, *Terebra circumcincta*, *Pecten medius*, *Protocardia pulchella*, and, attached to pumice, *Spondylus raoulensis*.

Surface of Ocean.

Plankton.—Situated in a vast expanse of ocean, Sunday Island, as might be supposed, frequently has cast up on its shore pelagic animals. Sometimes, as with *Ianthina*, *Spirula*, *Velella*, and *Physalia*, they are washed up in large numbers. Pelagic molluscs recorded in the present list include four species of *Ianthina*, *Recluzia lutea*, fourteen species of Pteropods, and several Cephalopods.

Floating Logs.—Besides numerous stalked cirripedes, crabs, and worms, there were found in logs cast up on the beaches *Saxicava arctica* and *Nausitoria aurita*, while *Uperotis clava* was taken from coconuts.

Literature and History.

1857. Pfeiffer, Dr. L. "Descriptions of Fifty-eight New Species of *Helicea* from the Collection of H. Cuming, Esq." Proc. Zool. Soc., 1856, p. 324. Describes two new species of land shells from Sunday Island, *Helix kermandeci* and *H. chimmoi*, collected by Lieut. Chimmo, presumably an officer of H.M.S. "Herald," which surveyed the island in 1854. *H. chimmoi* is omitted from the present list, as Iredale, who examined the type, is of opinion that the locality assigned to it is erroneous.

1873. Smith, E. A. "Description of a New Species belonging to the Genus *Vitrina*." Ann. Mag. Nat. Hist. (4), xi, p. 288. *V. kermadecensis* described from Sunday Island.

1873. Mousson. "Faune Malacologique de quelques Îles de l'Océan Pacifique Occidental, ii, Îles de Norfolk et de Kermandec." Journ. de Conch., xxi, p. 109. Records *Microcystis kermandeci* Pfeiffer, and describes as new *Vitrina ultima*, *Trochonanina exposita* and *Patula modicella* Férussac var. *vicinalis*. Of these, *V. ultima* is the same as *V. kermadecensis* Smith, while *P. modicella* var. *vicinalis* is omitted from the present list, as the type is lost and no specimens answering to Mousson's description have since been collected at Sunday Island. Mousson's specimens were collected by Dr. Graeffe.

1884. Hutton, F. W. "Revision of the Land *Mollusca* of New Zealand." Trans. N.Z. Inst., vol. 16, p. 186. *Vitrina kermadecensis* recorded from the Kermadecs, and also from Hobson's Glen, Auckland; but the latter locality is almost certainly an error.

1884–87. "Reports on the Scientific Results of the Voyage of H.M.S. 'Challenger.'" The "Challenger," on her famous voyage round the world, passed through the Kermadec Group on the 14th and 15th July, 1874. No landing was made on any of the islands, but the trawl was put over three times. Two casts were made between Sunday and Macauley Islands in 520 and 630 fathoms (Station 170), the bottom in both instances being volcanic mud. The following species of *Mollusca* were taken: *Spondylus ostreoides*, *Euplocamus pacificus*, *Amphitretus pelagicus*, *Eledone verrucosa*, and, on the surface, *Halopsyche gaudichaudi*. The trawl was again put over north of Sunday Island (Station 171) in 600 fathoms, bottom volcanic mud, the following *Mollusca* being obtained: *Pecten kermadecensis*, *Murex zelandicus*, *Cirroteuthis meangensis*. The above species were recorded in the undermentioned reports: *Nudibranchiata*, Dr. R. Bergh, vol. x, pt. 26, 1884; *Lamellibranchiata*, E. A. Smith, vol. xiii, pt. 35, 1885; *Gastropoda*, R. B. Watson, vol. xv, pt. 42, 1886; *Cephalopoda*, W. E. Hoyle, vol. xvi, pt. 44, 1886 (diagnoses of new species in Ann. Mag. Nat. Hist. (5), xv, 222); *Pteropoda*, Dr. P. Pelseneer, vol. xix, pt. 58, 1887.

1885–87. Tryon, G. W. "Manual of Conchology," 2nd series. Vol. i, 1885, p. 158, *Vitrina ultima*; vol. ii, 1886, p. 47, *Nanina exposita*; vol. iii, 1887, p. 38, *Helix modicella*.

1888. Cheeseman, T. F. "On the Flora of the Kermadec Islands, with Notes on the Fauna." Trans. N.Z. Inst., vol. 20, p. 151. Six species of marine Gastropods are recorded, while mention is made of a large limpet common on the rocks.

1893. Hedley, C., and Suter, H. "Reference List of the Land and Fresh-water *Mollusca* of New Zealand." Proc. Linn. Soc. N.S.W. (2), vii, p. 613. Recorded from the Kermadecs: *Helicarion ultimus*, *Microcystis kermadeci*, *Trochonanina exposita*, *Charopa modicella* var. *vicinalis*.

1894–95. Proc. Linn. Soc. N.S.W. The locality assigned to *Scutellastra kermadecensis* is disputed by Brazier (vol. ix, p. 18, 1894). Hedley then states that specimens were collected at Sunday Island by the crew of the New Zealand Government steamer "Hinemoa" (vol. ix, p. 465, 1895); but Brazier refuses to believe that this large limpet is found at Sunday Island, though he admits it occurs at Macauley Island (vol. ix, p. 566, 1895). The question is finally settled by Cheeseman, who states that he himself collected the type specimens at Sunday Island during his visit in the New Zealand Government steamer "Stella" in 1887 (vol. x, p. 221, 1895).

1899. Suter, H. "Malacological Communications from New Zealand." Journ. Malac., vol. viii, p. 54. *Scalaria australis* recorded from the Kermadecs.

1902. Suter, H. "On the Systematic Position of *Patella kermadecensis*, Pilsbry." Journ. Malac., vol. ix, p. 111. Branchial cordon and radula described and figured.

1905. Suter, H. "Revision of the New Zealand *Patellidae*, with Descriptions of a New Species and Subspecies." Proc. Mal. Soc., vol. vi, p. 346. *Helcioniscus craticulatus* is described from the Kermadecs.

1906. Suter, H. "Notes on New Zealand *Mollusca*, with Descriptions of New Species and Subspecies." Trans. N.Z. Inst., vol. 38, p. 316. Recorded from the Kermadecs: *Meleagrina radiata*, *Tutufa californica*, *Nassa zonalis*, *Purpura striata* var. *bollonsi*, *Terebra venosa*.

1907. Suter, H. "Notes and Additions to the New Zealand Molluscan Fauna." Trans. N.Z. Inst., vol. 39, p. 265. *Siphonaria diemenensis* recorded from the Kermadecs.

•1909. Suter, H. "Descriptions of New Species and Subspecies of New Zealand *Mollusca*, with Notes on a Few Species." Proc. Mal. Soc., vol. viii, p. 254. Recorded from the Kermadecs: *Drupa bollonsi*, *Tornatellina subperforata*.

1909. Suter, H. "The *Mollusca* of the Subantarctic Islands of New Zealand." Subantarctic Is. N.Z., vol. i, p. 1. Six species of marine molluscs recorded from the Kermadecs. Of these, I retain *Lemellaria ophione* and *Saxicava arctica*, but omit until authentic specimens are obtained *Cantharidus opalus*, *Trophon ambiguus*, *Chione stutchburyi*, and *C. yatei*.

1910. Iredale, T. "On Marine *Mollusca* from the Kermadec Islands and on the Sinusigera Apex." Proc. Mal. Soc., vol. ix, p. 68 (list of species reprinted in Proc. N.Z. Inst., 1910, p. 57). This is the first paper dealing with the *Mollusca* collected by the expedition to the Kermadec Islands in 1908, of which both Iredale and myself were members. Iredale records ninety-four species of *Gastropoda*, twenty-two of *Lamellibranchia*, and five of *Cephalopoda*. In the present list I have taken account of all of his species except *Erato corrugata* and *Rissoina polytropa*, as Iredale informs me that the shells so named belong to other species, as yet undetermined. Critical notes on several species of shells are given, together with a discussion on the sinusigera apex, which is recorded for several Kermadec species.

1910. Iredale, T. "Notes on *Polyplacophora*, chiefly Australian." Proc. Mal. Soc., vol. ix, p. 153. Contains an account of the Kermadec *Amphineura* collected in 1908, but none are assigned definitely to described species.

1911. Oliver, W. R. B. "The Geology of the Kermadec Islands." Trans. N.Z. Inst., vol. 43, p. 524. The following species are recorded from

the submarine volcanic tuffs of Sunday Island and outlying islets: *Turbo argyrostomus*, *Spondylus ostroides*, *Pecten kermadecensis*, *Arca decussata.* The correct names for these and others only generically identified at the time are given in the present list.

1911. Iredale, T. "On the Value of the Gastropod Apex in Classification." Proc. Mal. Soc., vol. ix, p. 319. A discussion on Gastropod apexes, mainly from Kermadec material, mentioning the following species: *Turris cingulifera*, *Planaxis brasilianus*, *Cerithiopsis sinon*, *Bullina scabra.*

1912. Iredale, T. "New Generic Names and New Species of Marine *Mollusca*." Proc. Mal. Soc., vol. x, p. 217. Descriptions of thirteen new species of *Gastropoda* from the Kermadecs. Seven new generic names proposed for Kermadec Gastropods—*Roya*, *Royella*, *Brookula*, *Jeannea*, *Quoyula*, *Heterorissoa*, *Neothais*.

1913. Berry, S. S. "*Nematolampas*, a Remarkable New Cephalopod from the South Pacific." Biol. Bull., vol. 25, p. 208. Description and figure of *N. regalis*, collected at Sunday Island.

1913. Iredale, T. "The Land *Mollusca* of the Kermadec Islands." Proc. Mal. Soc., vol. x, p. 364. An account of the land shells collected at Sunday Island in 1908. There are seventeen species enumerated, of which eleven are described as new.

1913. Suter, H. "Manual of the New Zealand *Mollusca*." In this work there are recorded from the Kermadec Islands thirty-three species of *Gastropoda* and nineteen of *Lamellibranchia*. Of these, thirty-two species were not taken by the expedition of 1908. There are no specimens in Mr. Suter's or any collection known to me, and Captain Bollons informs me he cannot remember collecting any of them. I have therefore omitted them in the present paper. They include the four species noted above (Subantarctic Is. N.Z., vol. i, 1909), and the following twenty-eight: *Haliotis virginea*, *Cantharidus purpuratus*, *Calliostoma pellucidum*, *Turritella carlottae*, *Struthiolaria papulosa*, *Natica zelandica*, *Epitonium zelebori*, *Cominella huttoni*, *C. maculosa*, *C. virgata*, *Murex octogonus*, *Trophon plebejus*, *Fulguraria arabica*, *Ancilla australis*, *Bathytoma cheesemani*, *Solemya parkinsoni*, *Nucula hartvigiana*, *Glycymeris laticostata*, *G. modesta*, *Venericardia australis*, *Divaricella cumingi*, *Tellina deltoidalis*, *Mesodesma subtriangulatum*, *Dosinia lambata*, *D. anus*, *Chione mesodesma*, *Soletellina nitida*, *Myodora striata*.

1914. Iredale, T. "The *Chiton* Fauna of the Kermadec Islands." Proc. Mal. Soc., vol. xi, p. 25. An account of the *Amphineura* collected at the Kermadecs in 1908. Nine species, all described as new. Fragments of four other species are generically determined only—*Acanthochites* (2), *Cryptoconchus*, *Lucilina*. An interesting comparison is made of the *Chiton* faunas of Lord Howe, Norfolk, and the Kermadec Islands.

1914. Berry, S. S. "Notes on a Collection of Cephalopods from the Kermadec Islands." Trans. N.Z. Inst., vol. 46, p. 134. An account of the Cephalopods collected in 1908 and subsequently. Three new species are described.

1914. Iredale, T. "Description of a New Species of *Cassidea*." Proc. Mal. Soc., vol. xi, p. 179. *C. royana*, from Sunday Island.

1915. Iredale, T. "A Comparison of the Land Molluscan Faunas of the Kermadec Group and Norfolk Island." Trans. N.Z. Inst., vol. 47, p. 498, *ante*.

EXPLANATION OF PLATES.

PLATE IX.

Fig. 1. Fig. 1a. *Cellana craticulatus* Suter subsp. *prolixus* n. subsp.
Fig. 2. Fig. 2a. *Cellana hedleyi* n. sp.
Fig. 3. Fig. 3a. *Cellana hedleyi* Oliver subsp. *corrugata* n. subsp.
Fig. 4. Fig. 4a. *Cellana vulcanicus* n. sp.
Fig. 5. Fig. 5a. *Cellana scopulinus* n. sp.
Fig. 6. Fig. 6a. *Schismope pacificus* n. sp.
Fig. 7. *Fissuridea bollonsi* n. sp.

PLATE X.

Fig. 8. *Philorene texturata* n. sp.
Fig. 9. *Haurakia kermadecensis* n. sp.
Fig. 10. *Notosetia electra* n. sp.
Fig. 11. *Zebina cooperi* n. sp.
Fig. 12. *Issella chiltoni* n. sp.
Fig. 13. *Epigrus insularis* n. sp.
Fig. 14. *Epigrus gracilis* n. sp.
Fig. 15. *Cerostraca iredalei* n. sp.
Fig. 16. *Amphithalamus sundayensis* n. sp.
Fig. 17. *Sundaya exquisita* n. sp.
Fig. 18. *Caecum solitarium* n. sp.
Fig. 19. *Turbonilla oceanica* n. sp.
Fig. 20. *Turbonilla sculpturata* n. sp.
Fig. 21. *Miralda austro-pacifica* n. sp.
Fig. 22. *Hinemoa punicea* n. sp.
Fig. 23. *Pyrgulina insularis* n. sp.
Fig. 24. *Raoulostraca inexpectata* n. sp.
Fig. 24a. *Raoulostraca inexpectata* n. sp. Apex.
Fig. 25. *Melanella kermadecensis* n. sp.
Fig. 26. *Melanella perplexa* n. sp.
Fig. 27. *Subularia perspicua* n. sp.
Fig. 28. *Melanella spinosa* n. sp.

PLATE XI.

Fig. 29. *Cithna wallacei* n. sp.
Fig. 30. *Scalenostoma suteri* n. sp.
Fig. 31. *Hexaplex puniceus* n. sp.
Fig. 32. *Mangilia hedleyi* n. sp.
Fig. 33. *Glyphostoma roseocincta* n. sp.
Fig. 34. *Iredalea subtropicalis* n. sp.
Fig. 35. *Kermia benhami* n. sp.
Fig. 36. *Mitramorpha expeditionis* n. sp.
Fig. 37. *Zafra kermadecensis* n. sp.
Fig. 38. *Zafra fuscolineata* n. sp.
Fig. 39. *Leuconopsis pacifica* n. sp.

PLATE XII.

Fig. 40. Fig. 40a. *Siphonaria raoulensis* n. sp.
Fig. 41. Fig. 41a. *Siphonaria cheesemani* n. sp.
Fig. 42. Fig. 42a. *Siphonaria macauleyensis* n. sp.
Fig. 43. Fig. 43a. *Siphonaria macauleyensis* Oliver subsp. *perplexa* n. subsp.
Fig. 44. *Siphonaria amphibia* n. sp.
Fig. 45. *Pronucula kermadecensis* n. sp. Left valve.
Fig. 46. *Chlamys cellularis* n. sp.
Fig. 47. *Limatula insularis* n. sp. Left valve.
Fig. 48. Fig. 48a. *Spisula belliana* n. sp. Left valve.
Fig. 49. *Spondylus raoulensis* n. sp. Left valve.

ART. L.—*The Chemistry of Flesh Foods—Part II.—(4.) The Composition and Nutritive Value of the Retail Cuts of Mutton and Lamb.*

By A. M. WRIGHT, F.C.S., Associate Editor, *Journal of Industrial and Engineering Chemistry.*

[*Read before the Philosophical Institute of Canterbury, 2nd December, 1914.*]

INTRODUCTION.

THIS investigation is a continuation of the research published in the Transactions of 1912.* The present study covers the results of an investigation concerning the composition and nutritive value of the various retail cuts of mutton and lamb.

SLAUGHTER TESTS.

In connection with this investigation ten average quality sheep and ten average quality lambs were taken from a line received at the Christchurch Meat Company's Islington works, and after being fasted for twenty-four hours were weighed alive and immediately slaughtered. In Table I will be found the weights and the percentages of the carcases and of the various by-products, based on the live weights.

TABLE I.—RESULTS OF SLAUGHTER TESTS.

	Ten Sheep.	Ten Lambs.	Sheep.	Lambs.
	lb.	lb.	Per Cent.	Per Cent.
Live weight	1,097·0	675·0	..	..
Dressed carcase (warm)	565·0	368·0	51·4	54·5
,, (cold)	554·0	364·0	50·5	54·0
Wool	68·2	72·0	6·2	10·7
Pelt	51·8	30·0	4·7	4·4
Blood	47·0	24·5	4·3	3·6
Head	33·4	21·8	3·0	3·2
Feet	16·5	13·4	1·5	2·0
Fat (caul, kidney, and intestinal) ..	66·5	32·5	6·0	4·8
Diaphragm (skirt)	4·1	2·4	0·4	0·4
Tongue..	4·0	2·9	0·4	0·4
Kidneys	2·7	1·7	0·3	0·3
Sweetbreads (thymus gland) ..	..	0·7	..	0·1
Brains	2·1	1·9	0·2	0·3
Heart	5·4	3·3	0·5	0·5
Lungs	12·4	8·2	1·1	1·2
Liver	16·9	8·3	1·5	1·2
Trachea (windpipe)	1·9	1·8	0·2	0·2
Spleen	1·9	1·0	0·2	0·1
Gall-bladder and contents ..	0·7	0·5	0·1	0·1
Small intestine	15·0	11·0	1·4	1·6
Large intestine	1·0	1·0	0·1	0·1
Other intestines	25·0	12·0	2·3	1·7
Stomach	37·0	18·0	3·4	2·7
Contents of stomach and intestines ..	104·5	35·5	9·5	5·5
Loss in dressing	14·0	2·6	1·3	0·4

* Wright, Trans. N.Z. Inst., vol. 45, pp. 1–17.

Retail Cuts.

On the day following a carcase of mutton weighing 55 lb., and a carcase of lamb weighing 35 lb. (cold weights), were selected from the twenty carcases from the slaughter test for the purpose of the main investigation. These carcases were split, and the left half of each, weighing 28 lb. and 18 lb. respectively, were cut into the joints usually offered for sale in the retail shops. In addition each cut was separated into lean meat, visible fat, and bone. In order to compare the various cuts as to their relative amounts of lean, fat, and bone the weights have been calculated to percentages. These figures, which represent the untrimmed cuts, are shown in Table II.

Table II.—Weights and Percentages of Lean Meat, Visible Fat, and Bone in the Retail Cuts.

—	Lean Meat.	Fat.	Bone.	Lean Meat.	Fat.	Bone.	Left Half.	
	lb.	lb.	lb.	Per Cent.	Per Cent.	Per Cent.	lb.	Per Cent.
Mutton—								
Leg	5·4	1·3	1·2	68·4	16·4	15·2	7·9	28·4
Loin	4·7	2·4	1·5	54·8	27·8	17·4	8·6	30·8
lder	5·2	0·9	1·0	73·2	12·7	14·1	7·1	25·4
and breast ..	2·0	0·6	1·8	45·5	13·5	41·0	4·4	15·4
							28·0	
Lamb—								
Leg	3·4	1·1	1·0	61·8	20·0	18·2	5·5	30·6
Loin	2·1	2·0	0·9	42·0	40·0	18·0	5·0	27·8
quarter ..	4·7	0·9	1·9	62·6	12·0	25·4	7·5	41·6
							18·0	

Relative Cost of the Retail Cuts.

Throughout New Zealand the prices of the various cuts differ considerably, and are liable to frequent fluctuation, so that absolute figures for the market retail price of the cuts would serve little purpose. It has been found, however, that by taking the cheapest cut as 1 the retail market prices bear relation to one another as follows:—

Mutton—Neck and breast..	1·00
,, Shoulder	1·50
Lamb—Fore quarter	1·67
Mutton—Leg	1·83
,, Loin	2·00
Lamb—Leg	2·17
,, Loin	2·17

Thus, with the price of neck and breast of mutton at 3d. per pound, the other cuts in the above order will be 4½d., 5d., 5½d., 6d., 6½d., and 6½d. per pound.

The Chemical Composition of the Boneless Meats.

The right half of the carcases used in the previous determinations was sampled for chemical analysis, the total boneless meat (lean and fat) of each cut being used for this purpose.

Moisture.—The moisture found in the various cuts ranged from 57·92 per cent. in the leg cut of the lamb to 40·12 per cent. in the loin cut of the same carcase; in general, the higher percentage of fat is found associated with the lower moisture-content.

Ash.—The percentage of ash or mineral salts varied from 0·89 per cent. in the leg cut of the lamb to 0·49 per cent. in the loin cut of the same carcase. The ash is chiefly composed of the chlorides and phosphates of potash, soda, lime, and magnesia, which contribute largely towards the structure of the bone and other tissues. They also aid the digestive functions, and increase the palatability of the cooked meats. There is no evident relation between market prices and the palatability of the different cuts as indicated by the amounts of mineral salts, the cheaper cuts showing as much ash as the more expensive.

Fat.—This varies from 48·38 per cent. in the lamb loin cut to 22·60 per cent. in the mutton leg cut. As indicated above, it is noted that in general the higher the fat the lower will be found the moisture-content. The amounts of fat bear no relation to the market price of the meats.

Protein. Protein is the most important food constituent of meat, and varies in the cuts from 16·75 per cent. in the lamb leg to 9·56 per cent. in the lamb loin. The market prices charged for the cuts are not in proportion to the protein-contents.

Meat Bases.—These, while possessing but slight food-value, are of importance because of their influence on the palatability of the meat. They aid in giving cooked meat its flavour, and serve in part as stimuli to the digestive glands. No relation between the market price and the amount of meat bases seems to exist; indeed, one of the highest-priced joints, the lamb loin, contains 0·52 per cent., while the lowest-priced meat, the neck and breast of mutton, contains the same amount.

The results of the chemical analyses of the bone, less meat of the various retail cuts, are shown in Table III.

TABLE III.—CHEMICAL COMPOSITION OF THE BONELESS MEAT OF THE RETAIL CUTS.

	Mutton.				Lamb.		
	Leg.	Loin.	Shoulder.	Neck and Breast.	Leg.	Loin.	Fore Quarter.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Moisture	49·08	46·64	55·94	43·35	57·92	40·12	44·42
Ash	0·87	0·67	0·76	0·55	0·89	0·49	0·64
Fat	22·60	37·48	27·66	42·56	24·08	48·38	40·54
Total nitrogen	2·956	2·394	2·495	2·112	2·742	1·688	2·283
Cold-water extract—							
Total solids	4·75	3·49	3·65	3·06	4·39	2·47	3·31
Ash	0·75	0·52	0·56	0·44	0·71	0·43	0·51
Organic extractives ..	4·00	2·97	3·09	2·62	3·68	2·04	2·80
Nitrogen	0·596	0·430	0·485	0·375	0·566	0·311	0·421
Coagulable proteids ..	1·72	1·31	1·36	1·18	1·66	0·86	1·21
Non-coagulable proteids..	0·18	0·12	0·23	0·11	0·22	0·11	0·16
Total soluble proteids ..	1·90	1·43	1·59	1·29	1·88	0·97	1·37
Meat bases	0·92	0·62	0·72	0·52	0·78	0·52	0·63
Insoluble protein	14·74	12·24	12·55	10·79	14·87	8·59	11·62
Total protein	16·64	13·67	14·14	12·08	16·75	9·56	12·99
Crude protein	18·48	14·94	15·56	13·18	17·11	10·56	14·27

CONCLUSION.

While some of the cuts are less tender and are therefore more difficult to prepare for use than others, yet the constituents (mineral salts and meat bases) which give flavour to cooked meats show little difference in the various cuts, and since the digestibility of the protein is independent of

the cut or the method of cooking* it is evident from a study of the figures presented above that the retail market prices charged for the various cuts are not governed by the relative food-values or by the palatability of the meats.

For permission to publish these results the author desires to express his thanks to the Christchurch Meat Company (Limited), in whose laboratory the work has been carried out.

ART. LI.—*Note on the Determination of Milk-fat.*

By A. M. WRIGHT, F.C.S., Associate Editor, *Journal of Industrial and Engineering Chemistry.*

[*Read before the Philosophical Institute of Canterbury, 2nd December, 1914.*]

ACCORDING to Thorpe,† the official Adams process for determining the fat-content of milk has largely been superseded by the method of Gottlieb. The same writer states that Gottlieb's method is perhaps the easiest and best of all methods of fat-estimation.

Olsen‡ states that it is conceded that higher percentages of fat are generally obtained by the Gottlieb than by the present ether-extraction method.

While a considerable amount of data have been published showing the comparative results obtained by the use of Gottlieb's method in determining the fat-content of various dairy-products, including milk, the author has been unable to find a record of any results comparing the Adams process with Gottlieb's in the estimation of the fat-content of fresh milk.

The author recently had occasion to compare these processes in connection with the examination of a number of milk-samples, and the following results are now put on record.

.e No.	Adams's Process. Fat per Cent.	Gottlieb's Method. Fat per Cent.
1	3·76	3·84
2	3·68	3·82
3	3·86	4·02
4	3·58	3·64
5	3·98	4·14
6	3·94	4·04
7	3·91	4·00
8	3·79	3·88
9	4·06	4·18
10	3·86	4·00
11	3·70	3·76
12	3·75	3·91
13	3·80	3·94
14	3·65	3·73
Average	3·81	3·92

dley and Emmett, Bulletin 162, U.S.A. Dept. Agric. O.E.S.; also Grindley, Monjonnier, and Porter, Bulletin 193, U.S.A. Dept. Agric. O.E.S.

† Dict. Applied Chem., rev. ed., vol. 3, pp. 531, 532.

‡ Bulletin No. 105, U.S. Dept. Agric., p. 109.

The method of Gottlieb as described by Thorpe* was used in the above determinations, and is as follows: 10 c.c. of milk are measured into a tall, narrow cylinder, graduated in 0·5 c.c., and holding 100 c.c.; 1 c.c. of ammonia (sp. gr. 0·96) is added, and then 10 c.c. of alcohol. The mixture is well shaken; 25 c.c. of ether, which need not be dry, are added; and the contents of the tube well mixed. Finally, 25 c.c. of light petroleum are added, and the mixture again well shaken. It is essential that the contents of the tube be mixed after the addition of each reagent, or the results may be very low. The cylinder is then left for six hours, the volume of the ethereal solution measured, and 50 c.c. removed, evaporated, and the fat dried and weighed.

The question naturally arises as to whether or not the increased result is due to some substances other than fat, introduced by the reagents used in the Gottlieb method, or through their action. A blank test of the chemicals used was made and the small amount of residue obtained on evaporation deducted from the results.

Olsen† has shown that the results obtained by the Gottlieb method are the true fat-content of dairy-produce, and this is of special importance in the case of milk or other dairy-products containing only small amounts of fat.

ART. LII.—*On the Influence of Pressure on the Solubility of Tricalcic Phosphate in Carbonic-acid Solutions.*

By P. S. NELSON, M.Sc.

Communicated by Dr. Evans.

[*Read before the Canterbury Philosophical Institute, 1st July, 1914.*]

ROBERT WADINGTON, in 1871 (Journ. Chem. Soc., p. 80), treated samples of bone-ash repeatedly with a solution of carbon dioxide in water, and found a solubility of tricalcic phosphate of 0·147 gram per litre. T. Schloesing (Comp. Rend., 1900, vol. 131, pp. 149–53) determined the solubility of freshly precipitated tricalcic phosphate in pure water, in carbon-dioxide solutions of various strengths, and in similar solutions containing calcium bicarbonate. He found in 1 litre of—

Water saturated with carbon dioxide	Water $\frac{1}{3}$ saturated	Water $\frac{1}{25}$ saturated	Pure water	Calcium-bicarbonate solution
91·9	48·5	6·9	1	1

milligrams of phosphoric acid, as P_2O_5. This result seemed to suggest that the solubility of the tricalcic phosphate depended, to some extent at least, on the amount of carbon dioxide in solution.

As no record dealing with the question could be found in the *Journal of the Chemical Society*, nor in the *Journal of the Society of Chemical Industry*, it was determined to ascertain the effect of carbon dioxide at higher pressures than atmospheric upon the solubility of the phosphate.

* Dict. Applied Chem., rev. ed., vol. 3, pp. 531, 532.
† Bulletin No. 105, U.S. Dept. Agric., p. 109.

Apparatus.

After the breaking of the first apparatus, which was composed partly of glass, the apparatus used throughout the work was that shown in fig. 1, half in view and half in section. It consists of a heavy copper tube, fitted with a heavy cap, through which passes a copper capillary tube. The

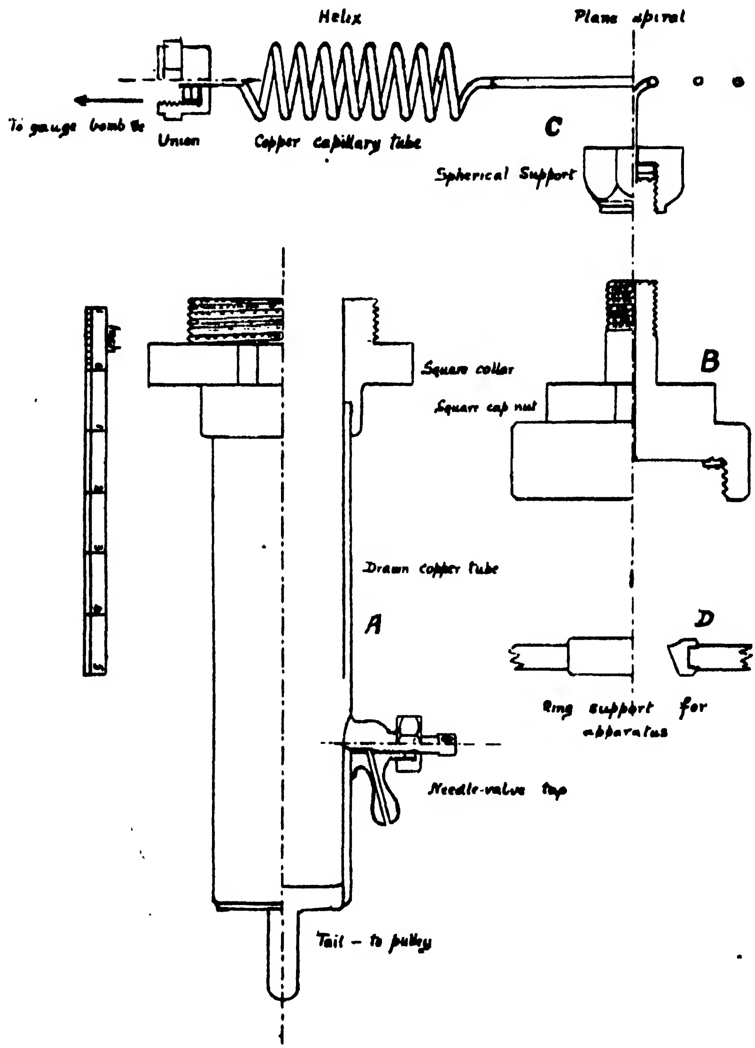


FIG. 1.

latter is connected to a bomb of liquid carbon dioxide, and a pressure-gauge registering up to 40 atmospheres. The apparatus is shaken by carrying the bottom round in a horizontal pulley run by an electro-motor. The tube bears at the side a small needle valve, through which the solution can be run off.

Method.

A small quantity of Merck's pure precipitated tricalcic phosphate is placed in the apparatus, and about 330 c.c. of water added. After saturation at the required pressure with carbon dioxide, the whole is shaken for five hours, then allowed to stand for eighteen hours, after which the solution, which is quite clear and bright, is run off through the needle valve. The phosphate is estimated by an adaptation of Woy's molybdate method (Chem. Zeit., vol. 21, p. 442). The phosphate is precipitated as ammonium phosphomolybdate, which, after solution in ammonia and reprecipitation by nitric acid, is heated in a Gooch crucible to dull redness. By this means a dark-blue substance is formed, phosphomolybdic anhydride, $24MoO_3 . P_2O_5$, which contains 3·946 per cent. of P_2O_5.

Experimental.

Series I.—The first series of experiments performed in the glass apparatus was unsatisfactory, but showed an increase of solubility with increase of pressure.

Series II.—About 0·75 gram of tricalcic phosphate was taken in 330 c.c. of water. The range of pressures was from 0·5 atmosphere up to 18 atmospheres, at half and 1 atmosphere intervals. The solubility of the phosphate, in terms of grams of P_2O_5 per litre of solution, varied from 0·0995 at 1 atmosphere to 0·3804 at 18 atmospheres, the curve being shown in fig. 2. The general trend shows a regular increase of solubility with increase of pressure.

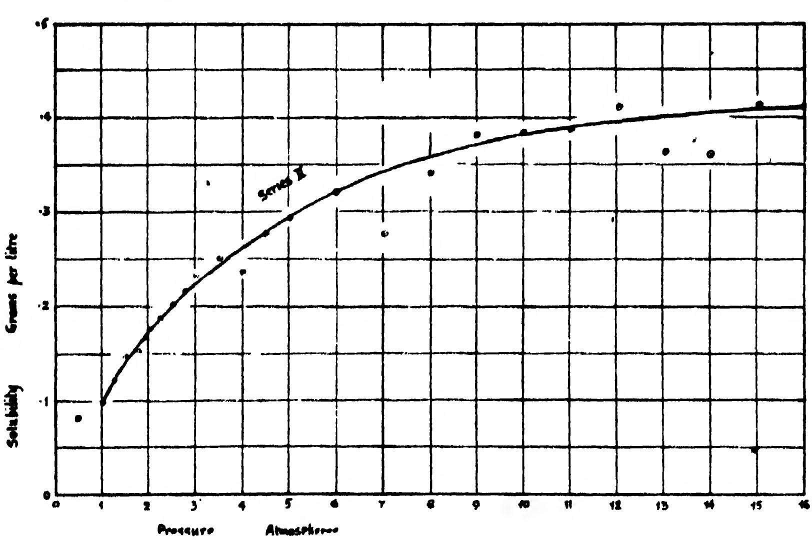


FIG. 2.

During this series of runs the enamel with which the apparatus was lined began to flake off from the interior, until at the end practically none remained. The surface was only very slightly attacked, and on no occasion could any appreciable blue cuprammonium salt be obtained on adding ammonium hydroxide and filtering. The tube was cleaned thoroughly and re-enamelled.

Series III.—Experiments made to ascertain, if possible, the effect of varying the amount of phosphate taken and the time of stirring showed that the solubility is increased both by increasing the amount taken and the time of shaking. Hereafter, therefore, weighed quantities of the phosphate were taken, the contents of the tube were shaken for five hours, then allowed to stand until run off for estimation.

Series IV.—0·25 gram was taken, giving results as shown in fig. 3. The two higher results were obtained by shaking for ten hours.

Series V.—1 gram taken. Both curves IV and V, though widely separated, show marked regularity, as far as they were taken.

Series VI.—0·5 gram taken. Here (see series VI, fig. 3) a very large drop was observable between 25 and 30 atmospheres, for which there was no accounting.

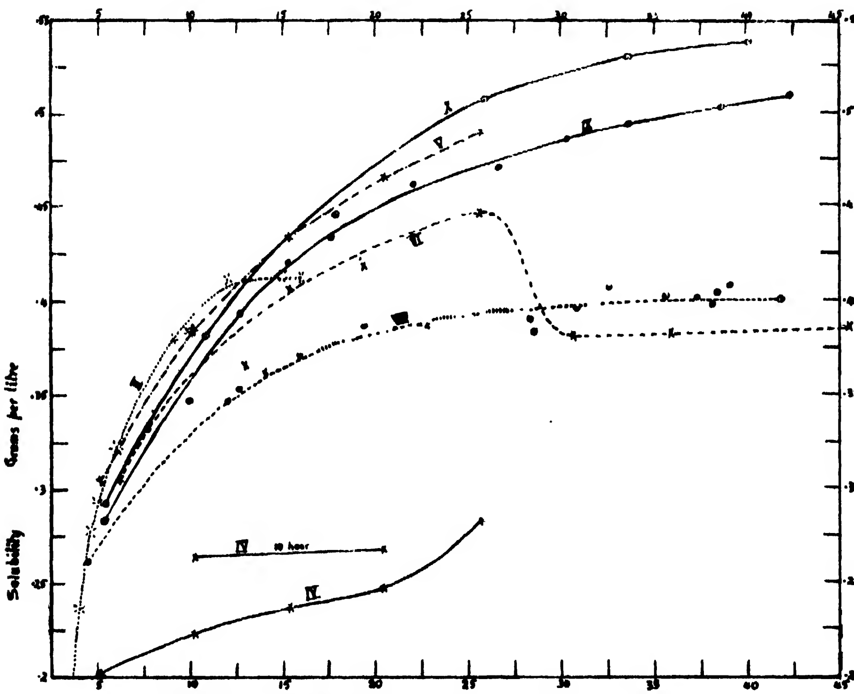


FIG. 3.

An attempt to confirm this peculiarity was made in *Series VII*, but the enamel began to flake in the second run. Later it flaked during the first run after re-enamelling, and on evaporating the solution the solid residue had a pale blue-green tint in the mass, and gave a slight blue coloration with ammonia. The slight surface action on the copper probably had some effect upon the solubility, which is here very irregular. After trying varnish in the tube without success, it was plated, as continuously as its structure would permit, with standard gold.

Series VIII was undertaken to verify, if possible, the peculiar results of series VI. The results, at pressures from 42 down to 4·4 atmospheres,

while consistent with one another, were not so with those of series VI. They show a regular increase of solubility with pressure. Here again after a few runs the presence of copper was found on evaporating the solution, rather more being present at high than at low pressures. The gold appeared to be quite intact, except for a ring about ⅜ in. wide round the top, above the part wetted by the solution during shaking.

Series IX (1 gram) and *Series X* (2 grams) also gave very regular results.

In order to show more clearly the relations between amount of phosphate taken, pressure, and solubility, all the curves are placed together in fig. 3.

Analyses were made of the following materials :—

A. The original material from the bottle.

B. The undissolved phosphate left in the bottom of the copper tube was collected, and dried at 100° C. It contained a very slight trace of copper, which was not estimated, and gave a very slight effervescence with nitric acid.

C. The phosphate was obtained by evaporating on the water bath the solution not required for estimation. The sample which was analysed for copper was from several high-pressure solutions, and contained more copper than usual. This material also gave an effervescence on treatment with nitric acid, showing the presence of a carbonate, derived probably from calcium bicarbonate in the solution. This carbon dioxide, however, was in too small a quantity to be estimated directly.

The results of average analyses were :—

	A.	B.	C.
CaO	48·68	48·90	50·45
P_2O_5	38·77	38·67	37·29
Loss (at red heat)	11·07	11·15	10·86
CuO	..	..	1·19
	98·52	98·72	99·79

The loss at red heat in A must be due to water only, and the analysis corresponds to $3{\cdot}18CaO.P_2O_5.2{\cdot}43H_2O$. If in B the loss is assumed to be due wholly to water, which is nearly true, the analysis shows the material to be $3{\cdot}2CaO.P_2O_5.2{\cdot}3H_2O$. In C, the ratio of CaO to P_2O_5 is 3·44. But the maximum of CaO which can combine with P_2O_5 is $3CaO$. Hence the remaining 0·44 CaO must be combined in some other way, which under the circumstances may be assumed to be with CO_2, as $CaCO_3$. Similarly, if the CuO is in the form of carbonate, the amount of CO_2 present will be 5·72 per cent., leaving 5·04 per cent. of loss at red heat as 1·07 molecule of water. Thus the analysis gives $3CaO.P_2O_5.0{\cdot}44CaCO_3.0{\cdot}02CuCO_3.1{\cdot}07H_2O$. It is also possible that some of the CuO may be combined with P_2O_5 instead of with CO_2.

The soluble compound which is formed is unstable, since it is deposited as a precipitate when the carbon dioxide is removed, either on standing, or more completely on boiling. The presence of calcium carbonate, or in solution calcium bicarbonate, indicates that an interaction has taken place, the carbonic acid having attacked the tricalcic phosphate with the formation of some calcium bicarbonate.

Conclusions.

(1.) The solubility of tricalcic phosphate in carbonic-acid solution increases directly with increasing pressure of carbon dioxide.

(2.) The solubility also increases with increasing time of contact between solvent and solute.

(3.) Differences of temperature appear to have very little effect.

(4.) The solubility is irregular when the surface of the solution-vessel is not uniform throughout a series of runs.

(5.) The presence of small quantities of copper in solution causes a small decrease in the solubility.

(6.) An interaction takes place between the tricalcic phosphate and the carbonic acid.

Notes.

In (2) practically no difference is observable between a solution run off after standing in the solution-vessel for eighteen hours and the same solution after standing forty hours. This is due to the sinking of the undissolved portion of the phosphate to the bottom of the vessel, and the consequent removal from the sphere of action.

In (3) any increase in solubility with rising temperature is probably counteracted by the concomitant lessened solubility of the carbon dioxide.

It is suggested that further work might be carried out to determine the solubility with varying times of contact between solid and solvent, and also to ascertain the effect of metallic salts, such as those of ammonium, calcium, and copper. More accurate work also could be done if the vessel were lined with a quite continuous coat of platinum.

Art. LIII.—*On the Deflection of the Plumb-line from the Vertical due to the Spheroidal Form of the Figure of the Earth, and its Effect on the Latitude of Stations above the Mean Sea-level.*

By W. T. Neill, New Zealand Survey Department.

[*Read before the Otago Institute, 22nd September, 1914.*]

It is now well known that the attraction of mountains and elevated regions has a sensible influence on the plumb-line. These local deflections have been the subject of numerous investigations since 1854, when Archdeacon Pratt computed the effect of the attraction of the Himalaya Mountains on the plumb-line in North India (Phil. Trans., 1854).

In modern geodetic surveys the degree of precision in the determination of the apparent astronomical latitude by means of the zenith telescope is so great that the station error, as it is called, or the difference between the observed and computed latitudes, due to local causes, has become a part of the routine work.

The deflection of the plumb-line by the attraction of mountains or by the variation of the density of the underlying strata will not be further discussed, the object of the present investigation being to determine the

amount of deflection and its direction that a plummet will deviate from the vertical line, or normal, at its point of suspension, in the plane of the meridian, for any length of the suspending cord, due to the spheroidal form of the figure of the earth.

STATICS OF THE PROBLEM OF A PLUMMET SUSPENDED FROM A FIXED POINT.

Let PEP_1E_1, fig. 1, represent the meridian ellipse of the earth, PP_1 the axis of rotation or polar axis, and EE_1 the equatorial axis.

We can infer from consideration of the symmetry of the figure that a plumb-line suspended at the Poles or at the Equator does not deviate from the vertical, and that at all other latitudes there is a deviation.

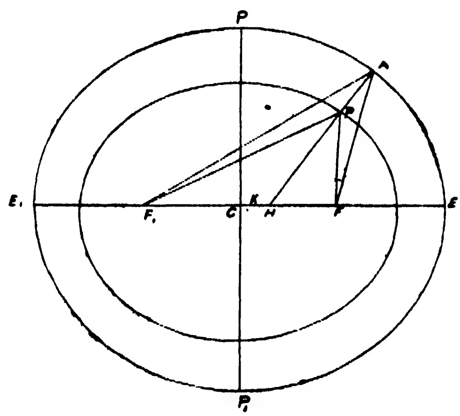


FIG. 1.

Let A be a point at the mean level of the sea, the latitude of which is ϕ', and suppose p a plummet suspended from the point A. Such a suspension can be actually obtained by means of a mine-shaft for small depths, but for the statement of the problem the existence of an opening in the earth need not be considered, for the solution of the problem gives the direction that a shaft takes when sunk by means of the plumb-line.

Let C be the centre of the earth, F and F_1 the foci.

The forces acting on p are the attraction of the earth and the tension of the suspending cord, the weight of the cord being neglected.

Through p let a confocal ellipse be described, and let it generate a spheroid by revolving about the axis PP_1. It is a well-known theorem in attractions that the potential within a spherical or ellipsoidal shell is constant, and therefore the force acting on p is the attraction of the above-generated spheroid, the surface of which is equipotential (Routh's "Analytical Statics," ii, p. 104).

A second theorem in attraction is: If there be any resultant force, due to any attracting mass, this force acts along the normal to that equipotential surface on which the point lies (Pierce's "Newtonian Potential Function," p. 38).

Since the tension of the cord is the resultant force, it is normal to the confocal ellipse, and therefore bisects the angle FpF_1.

Thus for all positions of p the direction of the resultant is towards the point A, and the angle FpF_1 is bisected by Ap produced.

Geometry of the Problem.

The problem to be solved can be stated as follows, in its most general form: Given the three sides of a triangle ABC, it is required to find the locus of a point, such that the line from the angle A to the point bisects the angle included between the lines from the angles B and C to the point.

The bisected angle contains the point A, and no restriction is placed on the size of the angle except that it is less than four right angles.

The deviation of the plumb-line is a particular case of the general form.

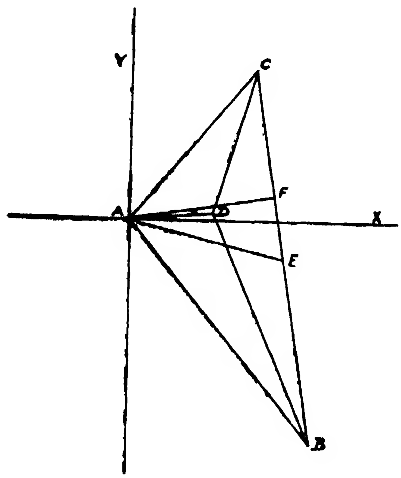


Fig. 2.

Let ABC, fig. 2, be the given triangle, and D a point such that the angles ADB, ADC are equal.

Take A as the origin of co-ordinates and the line bisecting the angle BAC as the axis of X.

Let r, θ be the polar co-ordinate of D. Denote the equal angles ADB, ADC by χ.

To obtain the equation to the locus of D, we have from the triangle ABD

$$\frac{r}{c} = \frac{\sin\left(\frac{A}{2} + \theta - \chi\right)}{\sin \chi}$$

$$\therefore \cot \chi = \frac{r + c \cos\left(\frac{A}{2} + \theta\right)}{c \sin\left(\frac{A}{2} + \theta\right)} \quad . \quad (1)$$

Again, from the triangle ACD we find

$$\cot \chi = \frac{r + b \cos\left(\frac{A}{2} - \theta\right)}{b \sin\left(\frac{A}{2} - \theta\right)} \quad . \quad (2)$$

Eliminating $\cot \chi$ we obtain

$$\sin 2\theta - mr \sin \theta + nr \cos \theta = o \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Wherein m has the value $\frac{b+c}{bc} \cos \frac{A}{2}$, and n the value $\frac{b-c}{bc} \sin \frac{A}{2}$,

or $2 \sin \theta - mr \sin \theta + nr = o$, since θ is small.

$$\therefore \sin \theta = - \frac{nr}{2 - mr} \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

The amount of the deflection is $r \sin \theta$, and is towards the Equator, since θ is positive.

To transform the equation to rectangular co-ordinates we substitute in (3) the values of the variable in terms of $x = r \cos \theta$, $y = r \sin \theta$, and $x^2 + y^2 = r^2$, and we have

$$nx^3 - myx^2 + 2xy + nxy^2 - my^3 = o \ldots\ldots\ldots\ldots (5)$$

When B and C are the foci of an ellipse the triangle ABC is isosceles if A is at the extremity of the minor axis.

Then $m = \frac{2}{b} \cos \frac{A}{2}$ and $n = o$.

Substituting these values of the constants in equation (5) we obtain

$$2\,xy - \frac{2}{b} \cos \frac{A}{2}\, yx^2 - \frac{2}{b} \cos \frac{A}{2} y^3 = o.$$

Therefore $y = o \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$

and $y^2 + \left(x - \frac{b}{2} \sec \frac{A}{2}\right) = \left(\frac{b}{2} \sec \frac{A}{2}\right)^2 \ldots\ldots\ldots\ldots\ldots\ldots (7)$

Equation (6), $y = o$, represents the axis of X, and for a plummet suspended at the Pole of the earth the axis of X is the vertical, and consequently there is no deviation from the vertical when the plummet is suspended from the Pole of the earth considered as an oblate spheroid.

Equation (7) represents a circle whose radius is $\frac{b}{2} \sec \frac{A}{2}$, and is therefore the circle circumscribing the triangle ABC.

The co-ordinates of the centre are $y = o$. $x = \frac{b}{2} \sec \frac{A}{2}$.

When the point A coincides with the extremity of the major axis of the ellipse the angle A vanishes, and we find

$$m = \frac{b+c}{bc} \text{ and } n = o.$$

These values of the constants substituted in equation (5) reduce it to the following two results:—

$$y = o \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

$$y^2 + \left(x - \frac{bc}{b+c}\right)^2 = \left(\frac{bc}{b+c}\right)^2 \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

The equation (8) represents the axis of X, and is the solution of the problem when the plummet is suspended at the Equator, from which we infer that for places situated on the Equator there is no deviation of the plumb-line from the vertical.

Equation (9) represents a circle of radiu $\frac{bc}{b+c}$ the co-ordinates of the centre being $y = o$. $x = \frac{bc}{b+c}$.

If in fig. 1 the inner ellipse represents the surface of the earth and A a point at an elevation above the surface, from which a plummet is suspended by a cord Ap, the line Ap produced bisects the angle FpF_1, and is normal to the surface of the earth at p; and the point A is therefore vertically above p. This condition holds for any length of the suspending cord, and the plumb-line at the earth's surface suspended from a point above it always coincides with the vertical.

The level surface at p is at right angles to Ap, and the angle EHp is the geographic latitude.

The level surface at A is at right angles to the line AK, which bisects the angle FAF_1, and the geographic latitude of A is the angle EKA. The difference of these angles is the variation of the latitude of p, due to the spheroidal form of the earth, and the elevation pA.

The level surfaces become more spherical as we recede from the earth, the point K moves along the major axis and ultimately coincides with the centre.

If ϕ_1 denotes the latitude of p and ϕ_2 the angle EKA, then $\phi_1 - \phi_2$ is the angle θ in equation (3), where A is the origin, and the line bisecting FAF_1 the initial, or the axis of X.

$$\text{Let } \delta_0 = HAF. \quad \delta = AFp. \quad \delta'_0 = HAF_1. \quad \delta' = AF_1p.$$
$$FpF_1 = \psi. \quad AP = r.$$
$$Fp = f_1. \quad F_1P = f.$$

It is now proposed to express AF, AF_1, and δ_0, δ'_0 in terms of pF, pF_1, and r.

The triangle AFp gives

$$AF^2 = f_1^2 + r^2 + 2f_1 r \cos\frac{\psi}{2} \quad \text{.........(10)}$$

$$f_1 \sin\delta = r\sin\delta_0 \quad \text{.........(11)}$$

$$\delta + \delta_0 = \frac{\psi}{2} \quad \text{.........(12)}$$

Similar expressions are obtained from the triangle AF_1p for AF_1, δ'_0, and δ'.

From (11)

$$\sin\delta = \frac{r}{f_1}\sin\delta_0$$
$$= p_1 \sin\left(\frac{\psi}{2} - \delta\right), \text{ where } p_1 = \frac{r}{f_1}. \quad .(13)$$

For even the highest mountain-tops the values of p_1 and δ are small, and equation (13) can be developed by Maclaurin's series, thus:

$$\delta = \tan^{-1}\left(\frac{p_1 \sin\frac{\psi}{2}}{1 + p_1\cos\frac{\psi}{2}}\right)$$
$$= p_1 \sin\frac{\psi}{2} - \frac{1}{2}p_1^2 \sin\psi + \&c. \quad \text{.........(14)}$$

Similarly, if $p = \frac{r}{f}$

$$\delta' = p \sin \frac{\psi}{2} - \frac{1}{2} p^2 \sin \psi + \&c. \ldots\ldots\ldots\ldots (15)$$

To take a numerical example, suppose that in latitude 45 S. it is required to find the difference in latitude between the top of a hill, 490 metres high, and the sea-level vertically below it, using Helmert's spheroid.

The value of θ can be computed by equation (3), but it can be found directly from (12), (14), and (15), as under.

$$\frac{\psi}{2} = \delta + \delta_0 = \delta' + \delta'_0$$

$$\delta'_0 - \delta_0 = \delta - \delta' \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (16)$$

Now, $\delta'_0 = \frac{A}{2} + \theta.$

$$\delta_0 = \frac{A}{2} - \theta.$$

$$\therefore \delta'_0 - \delta_0 = 2\,\theta.$$

$$\text{or } \theta = \frac{1}{2}(\delta'_0 - \delta_0) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (17)$$

And by the aid of (14) and (15) θ in seconds of arc is

$$\theta'' = \frac{1}{2}\frac{p_1 - p}{\sin 1''} \sin \frac{\psi}{2} - \frac{1}{4} \cdot \frac{p_1^2 - p^2}{\sin 1''} \sin \psi + \&c. \ldots\ldots\ldots\ldots (18)$$

$$p_1 - p = \frac{r}{f_1} - \frac{r}{f} = r\frac{(f - f_1)}{f f_1} = 10^{-6}\, x\, 893.$$

Computing the first term of (18) from the known value of $\sin \frac{\psi}{2}$ we find

$$\theta = 0''{\cdot}053$$

Thus the latitude of the hilltop is

$$\phi_2 = \phi_1 - \theta.$$
$$= 44^\circ\ 59'\ 59''{\cdot}947.$$

These differences of latitude are so small that in most cases they will be masked by the greater differences due to local conditions, which deflect the plumb-line; they possess the advantage that they can be easily computed, and the observed value can be corrected or reduced to the sea-level.

A summary of the three principal results is as follows:—

(1.) A plummet suspended from a point at the sea-level deviates from the vertical in the plane of the meridian, except at the Poles or the Equator; the amount of the deviation depends on the length of the suspending cord, and the deviation is towards the Equator.

(2.) A plummet suspended from a point above the surface of the sea-level, when the suspending cord just reaches the surface, always coincides with the vertical for any length of the suspending cord.

(3.) At heights above the surface the observed latitude is less than its corresponding value at sea-level.

ART. LIV.—*On Orthogonal Circles.*

By E. G. HOGG, M.A., F.R.A.S.

[*Read before the Philosophical Institute of Canterbury, 2nd December, 1914.*]

THE tripolar equation of the circle of radius r, which has its centre at the point O, whose trilinear co-ordinates are $(\alpha_0\beta_0\gamma_0)$, is

$$U \equiv a\alpha_0 X + b\beta_0 Y + c\gamma_0 Z - 2RS_0 - 2\Delta r^2 = o \text{ ....(i)}$$

where $S \equiv a\beta\gamma + b\gamma\alpha + c\alpha\beta$ and Δ is the area of the triangle of reference.*

Let d be the distance of O from H, the centre of the circle ABC. If U passes through H, then

$$R^2 (a\alpha_0 + b\beta_0 + c\gamma_0) = 2RS_0 + 2\Delta d^2$$

i.e.,
$$2RS_0 = 2\Delta(R^2 - d^2);$$

hence (i) may be written in the form

$$U \equiv a\alpha_0 X + b\beta_0 Y + c\gamma_0 Z = 2\Delta(R^2 + r^2 - d^2) \text{ ....(ii)}$$

If $d^2 = R^2 + r^2$, the equation of the circle having its centre at $(\alpha_0\beta_0\gamma_0)$ and cutting the circle ABC orthogonally is

$$U \equiv a\alpha_0 X + b\beta_0 Y + c\gamma_0 Z = o \text{ ....(iii)}$$

Its radius is given by the relation $r^2 = -\dfrac{R}{\Delta} S_0$, and its trilinear equation is

$$(a\alpha + b\beta + c\gamma)\left\{(c\beta_0 + b\gamma_0)\alpha + (a\gamma_0 + c\alpha_0)\beta + (b\alpha_0 + a\beta_0)\gamma\right\}$$
$$= 2\Delta(a\beta\gamma + b\gamma\alpha + c\alpha\beta).$$

From (iii) Ptolemy's theorem may be deduced. Let $r = o$ so that U reduces to a point-circle lying on the circle ABC. Suppose its centre O to lie on the minor arc BC of the circle ABC, and let D, E, F be the feet of the perpendiculars from O on BC, CA, AB respectively. We then have

$$-2R\,.\,OD = OB\,.\,OC,\quad 2R\,.\,OE = OC\,.\,OA,\quad 2R\,.\,OF = OA\,.\,OB.$$

Substituting these for $\alpha_0\beta_0\gamma_0$ in the equation $a\alpha_0 X_0 + b\beta_0 Y_0 + c\gamma_0 Z_0 = o$, we have

$$AO\,.\,BO\,.\,CO\ [-BC\,.\,AO + CA\,.\,OB + AB\,.\,OC] = o,$$

which is Ptolemy's theorem.

From the form of the equation

$$U \equiv a\alpha_0 X + b\beta_0 Y + c\gamma_0 Z = o,$$

it is seen that if U pass through the fixed point $(X_1Y_1Z_1)$, the locus of the centre of the circles which pass through a fixed point and cut the circle ABC orthogonally is the straight line whose equation is

$$X_1 a\alpha + Y_1 b\beta + Z_1 c\gamma = o.$$

The equation of the orthogonal circle passing through two fixed points $(X_1Y_1Z_1)$, $(X_2Y_2Z_2)$ is

$$\begin{vmatrix} X & Y & Z \\ X_1 & Y_1 & Z_1 \\ X_2 & Y_2 & Z_2 \end{vmatrix} = o.$$

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* Trans. N.Z. Inst., vol. 46, p. 319.

Suppose the centre of the orthogonal circle to lie on the line $p\alpha + q\beta + r\gamma = o$ at the point $\left(\frac{\lambda}{p}, \frac{\mu}{q}, \frac{\nu}{r}\right)$, where $\lambda + \mu + \nu = o$. The equation of the circle will be

$$\frac{\lambda a}{p}X + \frac{\mu b}{q}Y + \frac{\nu c}{r}Z = o,$$

showing that the circle passes through the pair of inverse points determined by the intersections of the circles

$$\frac{aX}{p} = \frac{bY}{q} = \frac{cZ}{r}.$$

Hence the theorem "All circles having their centres on a given line and cutting a given circle orthogonally pass through two fixed points which are inverse with respect to the given circle."

Let $A^1B^1C^1$ be a triangle inscribed in the circle ABC and circumscribed to the Brocard ellipse of the triangle ABC.

If $\lambda + \mu + \nu = o$, the trilinear ratios of A^1, B^1, C^1 may be taken as $\left(\frac{a}{\lambda}, \frac{b}{\mu}, \frac{c}{\nu}\right)$, $\left(\frac{a}{\mu}, \frac{b}{\nu}, \frac{c}{\lambda}\right)$, $\left(\frac{a}{\nu}, \frac{b}{\lambda}, \frac{c}{\mu}\right)$ respectively, for each of these ratios satisfies the equation of the circle ABC, and the line joining B^1C^1 is $\frac{\alpha}{a\lambda} + \frac{\beta}{b\mu} + \frac{\gamma}{c\nu} = o$, the envelope of which is $\sqrt{\frac{\alpha}{a}} + \sqrt{\frac{\beta}{b}} + \sqrt{\frac{\gamma}{c}} = o$.

Let three circles be described cutting the circle ABC orthogonally, each circle passing through two vertices of the triangle $A^1B^1C^1$. The centre of the circle through B^1C^1 is the pole of B^1C^1 with respect to the circle ABC, hence the trilinear ratios of the centre $(\alpha_0\beta_0\gamma_0)$ are

$$\left[a\left(-\frac{1}{\lambda}+\frac{1}{\mu}+\frac{1}{\nu}\right),\ b\left(\frac{1}{\lambda}-\frac{1}{\mu}+\frac{1}{\nu}\right),\ c\left(\frac{1}{\lambda}+\frac{1}{\mu}-\frac{1}{\nu}\right)\right]$$

and the tripolar equation of the circle is

$$\left(-\frac{1}{\lambda}+\frac{1}{\mu}+\frac{1}{\nu}\right)a^2X + \left(\frac{1}{\lambda}-\frac{1}{\mu}+\frac{1}{\nu}\right)b^2Y + \left(\frac{1}{\lambda}+\frac{1}{\mu}-\frac{1}{\nu}\right)c^2Z = o;$$

i.e.,
$$\frac{1}{\lambda}S_1 + \frac{1}{\mu}S_2 + \frac{1}{\nu}S_3 = o,$$

where
$$S_1 \equiv -a^2X + b^2Y + c^2Z.$$

Hence the envelope of the system of orthogonal circles is

$$\sqrt{S_1} + \sqrt{S_2} + \sqrt{S_3} = o.$$

It may be remarked that $S_1 = o$ is the equation of the locus of points whose pedal triangles are right-angled, the vertex of the right angle lying on BC.

The radical centre of the three orthogonal circles is the symmedian point of the triangle ABC, for if $L_1 \equiv \frac{\alpha}{a\lambda} + \frac{\beta}{b\mu} + \frac{\gamma}{c\nu}$, $L_2 \equiv \frac{\alpha}{a\mu} + \frac{\beta}{b\nu} + \frac{\gamma}{c\lambda}$, $L_3 \equiv \frac{\alpha}{a\nu} + \frac{\beta}{b\lambda} + \frac{\gamma}{c\mu}$, then the radical axes of the circles in pairs are

$$L_2 - L_3 = o,\ L_3 - L_1 = o,\ L_1 - L_2 = o,$$

and it is at once seen that the equations of these lines are satisfied by the co-ordinates (a, b, c) of the symmedian point.

The locus of the centres of these circles is the conic whose equation is

$$\frac{1}{\frac{\beta}{b}+\frac{\gamma}{c}}+\frac{1}{\frac{\gamma}{c}+\frac{a}{a}}+\frac{1}{\frac{a}{a}+\frac{\beta}{b}}=o.$$

This conic is the locus of points whose polars with respect to the triangle formed by the tangents to the circle ABC at the vertices A, B, C pass through the symmedian point of the triangle ABC.

To find the envelope of the circles cutting the circle ABC orthogonally and having their centres on the curve whose equation is

$$U\equiv\left(\frac{a^2}{a^2}-\frac{\beta\gamma}{bc}\right)^{\frac{1}{2}}+\left(\frac{\beta^2}{b^2}-\frac{\gamma a}{ca}\right)^{\frac{1}{2}}+\left(\frac{\gamma^2}{c^2}-\frac{a\beta}{ab}\right)^{\frac{1}{2}}=o.$$

Consider the points whose trilinear ratios are

$$\left(\frac{a}{\mu},\frac{b}{\nu},\frac{c}{\lambda}\right),\ \left(\frac{a}{\nu},\frac{b}{\lambda},\frac{c}{\mu}\right),\ \text{where } \lambda+\mu+\nu=o.$$

These points lie on the circle ABC, and the equations of the tangents to the circle at them are

$$\frac{a}{a}\mu^2+\frac{\beta}{b}\nu^2+\frac{\gamma}{c}\lambda^2=o.$$

$$\frac{a}{a}\nu^2+\frac{\beta}{b}\lambda^2+\frac{\gamma}{c}\mu^2=o.$$

These lines will meet at the point

$$a:\beta:\gamma=a(\lambda^4-\mu^2\nu^2):b(\mu^4-\nu^2\lambda^2):c(\nu^4-\lambda^2\mu^2),$$

which, since $\lambda^2-\mu\nu=\mu^2-\nu\lambda=\nu^2-\lambda\mu$, reduces to

$$a:\beta:\gamma=a(\lambda^2+\mu\nu):b(\mu^2+\nu\lambda):c(\nu^2+\lambda\mu).$$

For the locus of the intersections of the tangents we have

$$\frac{\gamma}{c}\lambda^2+\frac{a}{a}\mu^2+\frac{\beta}{b}\nu^2=o$$

$$\frac{\beta}{b}\lambda^2+\frac{\gamma}{c}\mu^2+\frac{a}{a}\nu^2=o,$$

giving

$$\lambda^2:\mu^2:\nu^2=\frac{a^2}{a^2}-\frac{\beta\gamma}{bc}:\frac{\beta^2}{b^2}-\frac{\gamma a}{ca}:\frac{\gamma^2}{c^2}-\frac{a\beta}{ab},$$

and hence the locus of the intersection of the tangents is

$$U\equiv\left(\frac{a^2}{a^2}-\frac{\beta\gamma}{bc}\right)^{\frac{1}{2}}+\left(\frac{\beta^2}{b^2}-\frac{\gamma a}{ca}\right)^{\frac{1}{2}}+\left(\frac{\gamma^2}{c^2}-\frac{a\beta}{ab}\right)^{\frac{1}{2}}=o.$$

The equation of the orthogonal circle may therefore be taken to be

$$a^2(\lambda^2+\mu\nu)X+b^2(\mu^2+\nu\lambda)Y+c^2(\nu^2+\lambda\mu)Z=o;$$

or, writing $-\lambda(\mu+\nu)$, $-\mu(\nu+\lambda)$, $-\nu(\lambda+\mu)$ for λ^2, μ^2, ν^2 respectively, the equation of the circle is

$$\mu\nu(-a^2X+b^2Y+c^2Z)+\nu\lambda(a^2X-b^2Y+c^2Z)$$
$$+\lambda\mu(a^2X+b^2Y-c^2Z)=o,$$

the envelope of which is

$$(-a^2X+b^2Y+c^2Z)^{\frac{1}{2}}+(a^2X-b^2Y+c^2Z)^{\frac{1}{2}}+(a^2X+b^2Y-c^2Z)^{\frac{1}{2}}=o.$$

Let O be the pole of a conic S circumscribing the triangle ABC, and let P, Q be the extremities of a chord of the conic passing through O. If circles be drawn with their centres at P. Q and cutting the circle ABC orthogonally, they will intersect each other on the circle whose centre is at O and which cuts the circle ABC orthogonally.

Let
$$S \equiv \frac{f}{\alpha} + \frac{g}{\beta} + \frac{h}{\gamma} = o;$$
and let $\lambda + \mu + \nu = o$ and $\lambda^1 = \mu - \nu$, $\mu^1 = \nu - \lambda$, $\nu^1 = \lambda - \mu$. We see by inspection that the two points whose trilinear ratios are $\left(\frac{f}{\lambda}, \frac{g}{\mu}, \frac{h}{\nu}\right)$, $\left(\frac{f}{\lambda^1}, \frac{g}{\mu^1}, \frac{h}{\nu^1}\right)$ lie on S. The equation of the chord PQ is
$$\lambda\lambda^1 \frac{\alpha}{f} + \mu\mu^1 \frac{\beta}{g} + \nu\nu^1 \frac{\lambda}{h} = o,$$
which is satisfied by (f, g, h) — the co-ordinates of the pole of the conic S.

The circles having their centres at P, Q and cutting the circle ABC orthogonally will be
$$S_1 \equiv \frac{afX}{\lambda} + \frac{bgY}{\mu} + \frac{chZ}{\nu} = o$$
$$S_2 \equiv \frac{afX}{\lambda^1} + \frac{bgY}{\mu^1} + \frac{chZ}{\nu^1} = o,$$
and for their intersections we have
$$afX : bgY : chZ = \frac{1}{\mu\nu^1} - \frac{1}{\mu^1\nu} : \frac{1}{\nu\lambda^1} - \frac{1}{\nu^1\lambda} : \frac{1}{\lambda\mu^1} - \frac{1}{\lambda^1\mu} = \lambda\lambda^1 : \mu\mu^1 : \nu\nu^1$$
since $\mu\nu^1 - \mu^1\nu = \nu\lambda^1 - \nu^1\lambda = \lambda\mu^1 - \lambda^1\mu = -\Sigma(\lambda^2)$.

Hence the locus of the intersection of S_1 and S_2 is
$$afX + bgY + chZ = o,$$
a circle having its centre at the pole (f, g, h) and cutting the circle ABC orthogonally.

If a circle cutting the circle ABC orthogonally meet the latter at the extremities of a chord passing through the symmedian point of the triangle ABC, it will pass through the two points whose pedal triangles are equilateral.

Any chord of the circle ABC which passes through the symmedian point (a, b, c) of the triangle ABC may be written
$$L \equiv \lambda\frac{\alpha}{a} + \mu\frac{\beta}{b} + \nu\frac{\gamma}{c} = o,$$
where $\lambda + \mu + \nu = o$.

The co-ordinates of the pole of L with respect to the circle ABC are given by
$$\alpha : \beta : \gamma = a\lambda : b\mu : c\nu;$$
hence the equation of the orthogonal circle is
$$\lambda a^2X + \mu b^2Y + \nu c^2Z = o.$$
Its form shows that it passes through the pair of inverse points given by
$$a^2X = b^2Y = c^2Z.$$

If P be one of the two points in the plane of the triangle ABC whose pedal triangles are equilateral, then AP sin A = BP sin B = CP sin C; hence the points determined by the above equations have their pedal triangles equilateral. It is at once seen that this pair of points lies on the Brocard diameter whose tripolar equation is

$$a^2(b^2-c^2)X+b^2(c^2-a^2)Y+c^2(a^2-b^2)Z=o.$$

We now proceed to find the equation of the circle cutting the nine-point circle of the triangle ABC orthogonally.

Let D, E, F be the middle points of BC, CA, AB respectively, and let $X_1=PD^2$, $Y_1=PE^2$, $Z_1=PF^2$, where P is a point whose tripolar co-ordinates are (X, Y, Z), then

$$2X_1=Y+Z-\frac{a^2}{2}$$

$$2Y_1=Z+X-\frac{b^2}{2}$$

$$2Z_1=X+Y-\frac{c^2}{2}$$

Let $U\equiv-a\alpha+b\beta+c\gamma=o$, $V\equiv a\alpha-b\beta+c\gamma=o$, $W\equiv a\alpha+b\beta-c\gamma=o$, be the equations of the sides of the triangle DEF, and let $(\alpha_0\beta_0\gamma_0)$ be the co-ordinates referred to the triangle ABC and $(\alpha_1\beta_1\gamma_1)$ the co-ordinates referred to the triangle DEF of the centre of a circle cutting the nine-point circle orthogonally, then

$$a\alpha_1=U_0,\ b\beta_1=V_0,\ c\gamma_1=W_0.$$

The equation of the circle referred to the triangle DEF is

$$a\alpha_1X_1+b\beta_1Y_1+c\gamma_1Z_1=o,$$

and this, when referred to the triangle ABC, becomes

$$U_0\left[Y+Z-\frac{a^2}{2}\right]+V_0\left[Z+X-\frac{b^2}{2}\right]+W_0\left[X+Y-\frac{c^2}{2}\right]=o;$$

i.e.,
$$a\alpha_0X+b\beta_0Y+c\gamma_0Z-\frac{1}{4}(a^2U_0+b^2V_0+c^2W_0),$$

which reduces to

$$a\alpha_0X+b\beta_0Y+c\gamma_0Z=2R\Delta(\alpha_0\cos A+\beta_0\cos B+\gamma_0\cos C).$$

The envelope of circles having their centres on the circle ABC and cutting the nine-point circle of the triangle ABC orthogonally is

$$a\left(X-\frac{1}{2}bc\cos A\right)^{\frac{1}{2}}+b\left(Y-\frac{1}{2}ca\cos B\right)^{\frac{1}{2}}+c\left(Z-\frac{1}{2}ab\cos C\right)^{\frac{1}{2}}=o.$$

If circles be described cutting the nine-point circle orthogonally and having their centres at the vertices of a triangle inscribed in the circle ABC and circumscribed to the Brocard ellipse of the triangle ABC, their points of intersection will lie on the curve

$$\frac{1}{a^2\left(X-\frac{1}{2}bc\cos A\right)}+\frac{1}{b^2\left(Y-\frac{1}{2}ca\cos B\right)}+\frac{1}{c^2\left(Z-\frac{1}{2}ab\cos C\right)}=o.$$

Let U_1 be the result of substituting in (i) $X_1Y_1Z_1$ for X, Y, Z respectively. Let a circle concentric with $U = O$ pass through the point whose tripolar co-ordinates are $(X_1Y_1Z_1)$, and let r' be the radius of this circle, then

$$U_1 \equiv a\alpha_0 X_1 + b\beta_0 Y_1 + c\gamma_0 Z_1 - 2RS_0 - 2\Delta r^2$$
$$O \equiv a\alpha_0 X_1 + b\beta_0 Y_1 + c\gamma_0 Z_1 - 2RS_0 - 2\Delta r'^2,$$

and therefore $U_1 = 2\Delta(r'^2 - r^2) = 2\Delta t^2$, where t is the length of the tangent from $(X_1Y_1Z_1)$ to the circle $U = O$.

Let t_1, t_2, t_3 be the tangents to the circle $a\alpha_0 X + b\beta_0 Y + c\gamma_0 Z = o$ from A, B, C respectively, then

$$\begin{aligned} 2\Delta t_1^2 &= \qquad\quad b\beta_0 c^2 + c\gamma_0 b^2 \\ 2\Delta t_2^2 &= a\alpha_0 c^2 \qquad\quad + c\gamma_0 a^2 \\ 2\Delta t_3^2 &= a\alpha_0 b^2 + b\beta_0 a^2 \\ 2\Delta \quad &= a\alpha_0 \quad + b\beta^0 \quad + c\gamma_0 \end{aligned}$$

Hence
$$\begin{vmatrix} t_1^2 & o & c^2 & b^2 \\ t_2^2 & c^2 & o & a^2 \\ t_3^2 & b^2 & a^2 & o \\ 1 & 1 & 1 & 1 \end{vmatrix} : o,$$

which, on expansion, gives the following relation connecting the lengths of the tangents from the vertices of a triangle to any circle cutting orthogonally the circumcircle of the triangle, viz.,—

$$t_1^2 \sin 2A + t_2^2 \sin 2B + t_3^2 \sin 2C = 4\Delta.$$

If t', t'', t''' be the lengths of the tangents to an orthogonal circle from the middle points of the sides of the triangle ABC, then

$$2\Delta t'^2 = a\alpha_0 m_1^2 + \frac{a^2}{4}(b\beta_0 + c\gamma_0)$$

$$2\Delta t''^2 = b\beta_0 m_2^2 + \frac{b^2}{4}(c\gamma_0 + a\alpha_0)$$

$$2\Delta t'''^2 = c\gamma_0 m_3^2 + \frac{c^2}{4}(a\alpha_0 + b\beta\ ),$$

where m_1, m_2, m_3 are the medians of the triangle ABC. Hence

$$2\Delta(t'^2 + t''^2 + t'''^2) = a\alpha_0\left(m_1^2 + \frac{b^2 + c^2}{4}\right) + b\beta_0\left(m_2^2 + \frac{c^2 + a^2}{4}\right)$$
$$+ c\gamma_0\left(m_3^2 + \frac{a^2 + b^2}{4}\right)$$
$$= a\alpha_0\,\frac{3(b^2 + c^2) - a^2}{4} + b\beta_0\,\frac{3(c^2 + a^2) - b^2}{4} + c\gamma_0\,\frac{3(a^2 + b^2) - c^2}{4}$$

also $2\Delta(t_1^2 + t_2^2 + t_3^2) = a\alpha_0(b^2 + c^2) + b\beta_0(c^2 + a^2) + c\gamma_0(a^2 + b^2)$.

Hence
$$2\Delta\left\{\Sigma(t_1^2) - \Sigma(t'^2)\right\} = \frac{1}{4}(a\alpha_0 + b\beta_0 + c\gamma_0)\,\Sigma(a^2);$$

i.e.,
$$\Sigma(t_1^2) - \Sigma(t'^2) = \frac{1}{4}\Sigma(a^2).$$

Art. LV.—*The Longitude, Latitude, and Height of the Hector Observatory, Wellington, New Zealand.*

By C. E. Adams, D.Sc., F.R.A.S., Government Astronomer of the Dominion of New Zealand.

[*Read before the Wellington Philosophical Society, 28th October, 1914.*]

(A.) Longitude.

1. In 1883 the difference of longitude between the Sydney Observatory, Australia, and the Mount Cook Observatory, Wellington,* New Zealand, was determined by means of the electric telegraph. The late Mr. H. C. Russell, Government Astronomer of New South Wales, observed at Sydney, and Mr. C. W. Adams, Geodesical Surveyor, observed at Wellington. The difference of longitude was found to be 1h. 34m. 16·984s. ± 0·020s.†

2. A point 198·38 links due north of the Mount Cook Observatory is the initial point of New Zealand surveys.‡

3. From this origin, and on the meridian of Mount Cook, the co-ordinates of the Bolton Street Observatory and of the Hector Observatory have been determined by Mr. J. D. Climie, Inspector of Surveys, Lands and Survey Department. These co-ordinates are,—

	North.	West.
	Links.	Links.
Mount Cook initial	0·00	0·00
Bolton Street Observatory, transit instrument ..	11077·90	2081·94 §
Hector Observatory, transit instrument	8518·50	3535·03

4. From the co-ordinates in 3 the differences of longitude, latitude, and azimuth have been calculated, using Clarke's 1880 Spheroid and Tables of Geodetic Factors,‖ with the following results:—

	Differences of—			
	Long.	Lat.		Azi.
	s.	′	″	″
Mount Cook initial – Bolton Street Observatory..	1·200	1	12·238	11·875
Mount Cook initial – Hector Observatory	2·037	0	55·550	20·165

* For the information of readers who have no local knowledge of New Zealand, it ought to be stated that the "Mount Cook Observatory" was demolished shortly after the observations were made in 1883, and a gaol built on the site; it was situated on a small knoll in the southern part of Wellington City, and had no connection with "Mount Cook," the highest mountain in New Zealand (12,349 ft. high).

† C. W. Adams: "Report on the Surveys of New Zealand for the Years 1883–84," Appendix No. 1, p. 3. Wellington: George Didsbury, Government Printer, 1884.

‡ Plan of Mount Cook Observatory, Wellington, in above report.

§ In Trans. N.Z. Inst., 1902, vol. 35, p. 441, Mr. Thos. King quotes 2097·2 links west. This was the position of the dog-vane on the Bolton Street Observatory, and not that of the transit instrument.

‖ C. E. Adams: Rep. Aust. Ass. Adv. Sci., p. 93, 1904; Dunedin.

5. In 1903–4 Dr. Otto J. Klotz* determined a number of transpacific longitudes, and included in his work Sydney, Southport, Norfolk Island, Doubtless Bay, and Bolton Street Observatory. The resulting differences of longitude and observers were,—

	Differences of Longitude.	Observers.
	H. m. s. s.	
Bolton Street Observatory – Doubtless Bay	0 5 08·941 ± 0·045	Thomas King, Otto Klotz.
Doubtless Bay – Norfolk Island ..	0 22 15·000 ± 0·021	Otto Klotz, F. W. O. Werry.
Norfolk Island – Southport ..	0 58 01·364 ± 0·008	F. W. O. Werry, Otto Klotz.
Southport – Sydney	0 08 50·495 ± 0·016	Otto Klotz, H. A. Lenehan, W. E. Raymond.

6. These observations give the complete circuit between Wellington and Sydney direct, and between Wellington and Sydney via Doubtless Bay, Norfolk Island, and Southport, thus:—

		H. m. s.	s.
Sydney–Wellington (Mount Cook) ..	E.	1 34 16·984	± 0·020
Mount Cook – Bolton Street ..	W.	0 0 1·200	
Bolton Street – Doubtless Bay ..	W.	0 5 8·941	± 0·045
Doubtless Bay – Norfolk Island ..	W.	0 22 15·000	± 0·021
Norfolk Island – Southport	W.	0 58 1·364	± 0·008
Southport – Sydney	W.	0 8 50·495	± 0·016
Giving an error in the circuit of		0 0 0·016s.	

7. The error 0·016s. is distributed over the differences of longitude, giving the following values:—

		H. m. s.
Sydney–Wellington (Mount Cook)	E.	1 34 16·986
Mount Cook – Bolton Street	W.	0 0 1·200
Bolton Street – Doubtless Bay	W.	0 5 8·931
Doubtless Bay – Norfolk Island	W.	0 22 14·998
Norfolk Island – Southport	W.	0 58 1·363
Southport – Sydney	W.	0 8 50·494

8. To determine the longitude of Wellington (Mount Cook), the difference Sydney–Wellington is applied to the longitude of Sydney.

The longitude of Sydney is given (*a*) as 10h. 4m. 49·54s. in the "British Nautical Almanac," 1914; (*b*) as 10h. 4m. 49·355s. using Klotz, p. 194; and (*c*) as 10h. 4m. 49·366s. using Klotz, p. 194, Albrecht's adjusted value for Potsdam.†

9. Hence the following values for Wellington, Mount Cook Observatory:—

	H. m. s.
From 8 (*a*)	11 39 6·526
From 8 (*b*)	11 39 6·341
From 8 (*c*)	11 39 6·352

* Otto J. Klotz: Report of the Chief Astronomer for the year ending 30th June, 1905; Appendix 3; Ottawa, 1906. Otto J. Klotz: Trans. N.Z. Inst., 1906, vol. 39, Article 2, p. 49; Wellington.

† Th. Albrecht: "Astronomische Nachrichten," No. 3993.

10. Another value for Wellington is obtained from the Canadian value of Norfolk Island, of—

	H.	m.	s.	
	11	11	41·146	(Klotz, p. 197).
	0	22	14·998	Paragraph 7.
Doubtless Bay	11	33	56·144	
	0	5	8·931	Paragraph 7.
Bolton Street	11	39	5·075	
	0	0	1·200	Paragraph 7.
Wellington (Mount Cook) ..	11	39	6·275	

11. The adopted value for the longitude of Wellington, Mount Cook, is 11h. 39m. 6·31s. (=174° 46′ 34·65″); Mount Cook – Hector Observatory, 2·04s., giving 11h. 39m. 4·27s. (= 174° 46′ 4·05″) as the adopted longitude of the Hector Observatory.

(B.) Latitude.

12. The latitude of the Hector Observatory is derived by triangulation from that of the Mount Cook Observatory, the latitude of which was determined by Mr. C. W. Adams in 1883 by zenith telescope observations of 99 pairs of stars from the Melbourne General Catalogue for 1870.

13. The latitude of the Mount Cook Observatory is S. 41° 18′ 0·59″ ± 0·05″.*

14. The latitude of the Mount Cook initial is S. 41° 17′ 59·30″ from 3 and 4.

15. The latitude of the Hector Observatory transit pier is S. 41° 17′ 3·75″, applying the difference in latitude in 4 of 55·55s.

(C.) Height.

16. The height of the top of the transit pier at the Hector Observatory was determined by the Public Works Department, by careful levelling from the tide-gauge at the Wellington Harbour Board Wharf; and was found to be 415·643 ft. above the mean sea-level determined by the harmonic anaylsis of the tide-gauge records for the year 1909.

* C. W. Adams: Surveys of New Zealand, Report for 1882–83, p. 11. Wellington: Government Printer.

ART. LVI.—*New Zealand Bird-song: Further Notes.*

BY JOHANNES C. ANDERSEN.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1914.*]

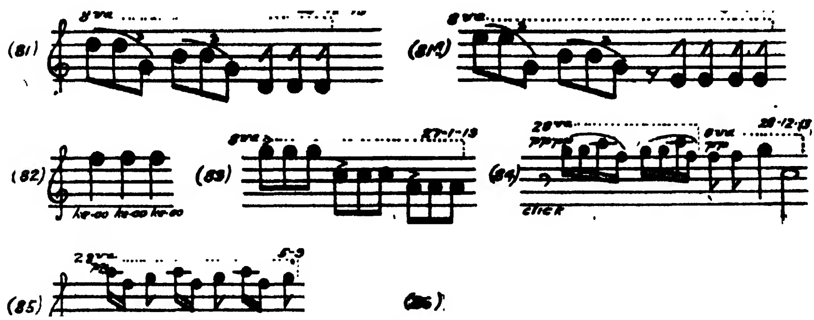
THE figures accompanying this article contain the new notes observed since publication of the paper in the Transactions of 1912 (Trans. N.Z. Inst., vol. 45, p. 387). As before, for convenience of reference, the variations in the notes of each species of bird have been numbered consecutively from (1) onwards, the earlier numbers appearing in the Trans. N.Z. Inst., vol. 41, p. 422; vol. 43, p. 656; and vol. 45, p. 387: reference is at times made to these earlier-numbered variations. The notes from the bush in the vicinity of Hokitika were noted at a time when the birds were not yet in full spring song—from the middle of July, through August, and into the first week of September, 1914—the weather being generally fine, but with only two or three really warm days. Those noted during the summer of 1913–14 are from the Stony Bay Bush, Banks Peninsula. This bush had been preserved uncut from the time of settlement of the Peninsula; but old Mr. Boleyn dying last year, the sons have now commenced the destruction of the bush, a sawmill being erected in 1914. When notes were heard on one day only, the date on which they were heard is given.

THE TUI.

There was little variation of song in 1913–14, and few birds singing. The common theme was as in (80). The full theme was heard only twice or three times; more often it discontinued at the double bar at 3, this portion of the song occupying three to four seconds in utterance; less often

it included all up to the double bar at 4. The sound of the notes was flute-like, the last ones only being susceptible of vocalization. The final two notes were often uttered alone. The parts of the theme numbered 3 and 4 were extremely varied, as shown in (80A) to (80G) inclusive. Whilst singing, the bird sat with head thrust out and upwards until the *kraw* was uttered, when it was lowered and thrust downwards, and kept down for the second four notes: these were almost always four in number; occasionally three or five. The themes in (81) and (81A) are variants made by using the notes

of part 3 in (80) preceded by runnel notes in triplets. The reedy note (82) was a ninth higher than the note of last year as in (38): it was heard on most days, but only occasionally. The triplets in (83) are a variant of the theme (69), one of the runnel songs: it was uttered in about a second. No. (84) is part only of a bubbling song. Though only about 50 ft. away from the bird, the first part was barely audible, and was led up to by a soft click: clicks were interspersed if the song was long continued,

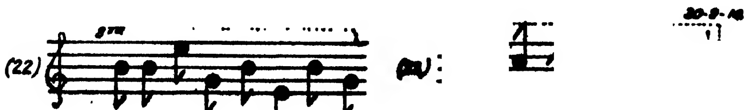


and (84) is only part of the song heard. The latter part was more deliberate and much louder, in comparison, than the former, yet still very soft and sweet. This seemed a greater effort to the bird than the ordinary song; the head was thrust well out and upwards, the throat quivering right round the neck and down to the breast; the beak was partly open at times. The theme noted occupied about three seconds. The foregoing are all from Boleyn's Bush, but these delightful sounds are now being banished by those of the axe.

The notes of (85), uttered softly like the notes of the bubbling song, were sounded whilst the bird dropped with closed wings from a height into the tree: they occupied little over a second. Many bubbling songs were heard on occasional days, differing from those recorded, but they were not repeated often enough for their sequence to be caught and noted. The sounds *kree*, *kraw*, *krurr*, *tsrr*, and other unmusical sounds, were never heard at Hokitika; and, instead of the common bell notes of the Peninsula, a guggle on *d* was sounded (86), the sound being that of a wooden mallet striking a bell quickly.

THE BELL-BIRD.

During the summer of 1913–14 only one bell-bird was seen in the Stony Bay Bush, but no note whatever was heard. In the bush on the south side



of the Hokitika River, a mile from the town, the pleasing cheery theme of (22) was heard on several occasions. In (23), heard at Bluespur, the prolonged *f* was a vibrato containing four or five notes.

THE GREY WARBLER.

No. (21) is rather a little soliloquy than a song: it sounded tentative, as if the bird were trying its voice, and might break into song at any part of this uncertain prelude; but the song rarely followed. The opening was varied as in (21A), and the whole was sung more softly than the ordinary song. The usual rambling indeterminate song was heard many times on

the West Coast, and a few new definite themes were noted. That of (22) was repeated, twice or more in succession, and was heard on different days at Mahinapua; (23), heard at Bluespur, was repeated several times, as were (24), the opening varied as in (24A), and (25); the last two themes were heard at Fisherman's Creek, opposite Hokitika, on the south side of the river. The notes of (24A) were at times sounded alone.

THE YELLOW-BREASTED TIT.

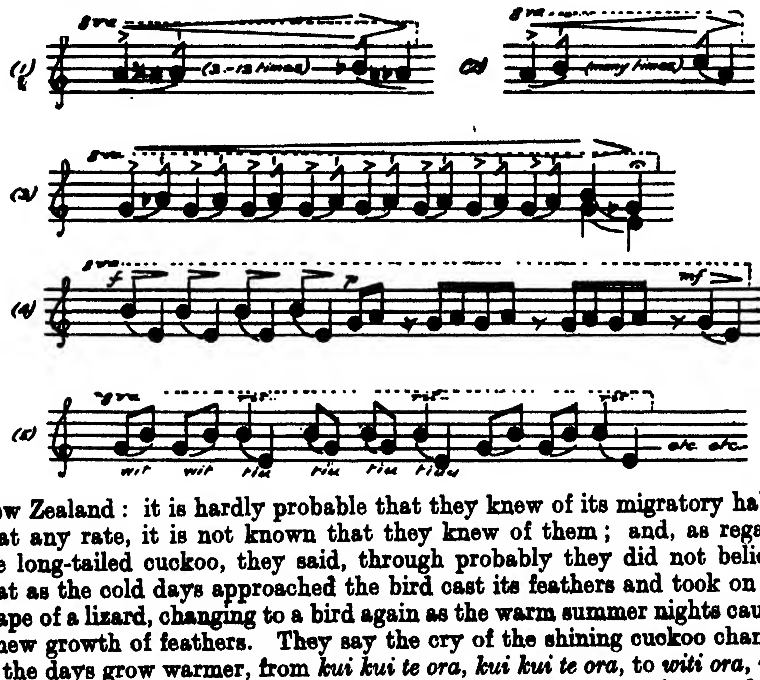
The ordinary song (1) was varied as in (8), at Stony Bay Bush, the song occupying about two seconds. The variation (9), one and a half seconds, was heard at Fisherman's Creek, Hokitika.

THE LONG-TAILED CUCKOO.

This was not heard in 1913–14; but whilst at Hokitika I was several times conversing with Mr. J. Cunningham, surveyor, who has had long experience in both North and South Island bush, and he informed me that on one occasion he was camped on the western slope of a sharp ridge between Coromandel and Thames: hearing a great twittering, and attracted by its unusual sound, he investigated, and found large numbers of long-tailed cuckoos gathered together. Suspecting they might be assembling for migrating, he watched all night, but they remained that night and next day, when still more came, till they were there "in hundreds." He watched next night too, but knew he must have dozed for a short time, as in the morning all were gone: they must have left between 2 o'clock and day-break.

The Shining Cuckoo.

Five years ago the notes of (1) and (2) were taken down, and the bird noted as unknown, as it was elusive and would not permit itself to be seen; but on speaking to another North-Islander I discovered the notes were those of the shining cuckoo. They have been heard every year in Boleyn's Bush, Stony Bay, being noted on the 28th December, 1913, as in (3). The notes start fairly loudly, in a clear open whistle, and gradually increase in loudness, dying off on the final slur; the interval of the slur varies, as indicated. In each couple of notes the first is accented, the second staccato. The number of upward slurs constantly varies. The theme (3) may be whistled independently, or continued into (4) or (5); and again (4) and (5) may be whistled independently. The Maori called the shining cuckoo "the bird of Hawaiki," as though they had known it before their migration to

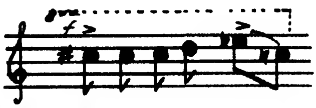


New Zealand: it is hardly probable that they knew of its migratory habits —at any rate, it is not known that they knew of them; and, as regards the long-tailed cuckoo, they said, through probably they did not believe, that as the cold days approached the bird cast its feathers and took on the shape of a lizard, changing to a bird again as the warm summer nights caused a new growth of feathers. They say the cry of the shining cuckoo changes as the days grow warmer, from *kui kui te ora, kui kui te ora*, to *witi ora, witi ora*. The variants (4) and (5) were more frequent on hot north-west days, and on those days the bird seemed most lively in song; the upward slurs of (5) might be vocalized *wit*, and all the downward slurs *tiu*, but I have heard no notes that could be vocalized either *kui kui te ora* or *witi ora*.

The Haurikiriki.

In the bush close to Hokitika I heard the theme (4), and thought I recognised the slurred note, though the others, except in quality, were new. There were several birds, feeding and travelling together: one would start the song, others would join in on the second or third note, and all the birds, apparently, come in on the slur. It was a bright, cheerful call, and as soon as I saw the singers I recognized them at once as the bird I have doubtfully called a hedge-sparrow in previous notes: some have suggested it may

be a brown creeper. I described the bird and its call to Mr. Cunningham, the surveyor, and he said it was known in the North Island as the haurikiriki, and that its liveliness was always a sign of spring and a spell of fine

(4)  (5) 

(6) 

weather. The song (6) was heard in the Stony Bay Bush on the 13th January, 1912, and other days: the full song only occasinally; more often it would break off after the first or second slur. In the achromatic drop ending the song seven or eight notes were sounded, so there may be intervals here even less than quarter-tones; the run had the sound of whistling through water, and occupied about one second.

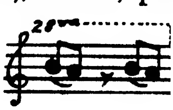
THE BUSH-CANARY.

I saw one bush-canary whilst travelling on the coach towards Kanieri Township, and it uttered the pleasant slurred note (1), which sounded very like the familiar *sweet* of its cage namesake.

(1) 

THE BLIGHT-BIRD.

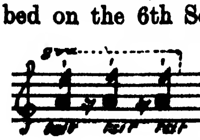
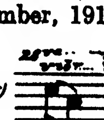
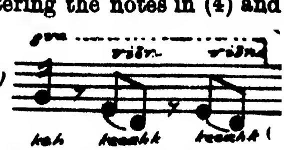
The common call, always heard when the bird moves about searching for food, is as in (3), a clear, plaintive slur. A soft conversational call

(3)  (4) 

(4) was heard at Mount Misery, Hokitika, whilst two birds sat in a tree preening themselves and moving about: it was the faintest twitter, barely audible, though the birds were only 10 ft. to 12 ft. distant.

THE SEA-MARTEN (TERN).

Two sea-martens, or sea-swallows, were flying above the shingly Hokitika River bed on the 6th September, 1914, uttering the notes in (4) and (5)—

 (5)  (6) 

sometimes the single whistling notes of (4), and sometimes a single vibrato drop from *c* to *a* (five notes to the vibrato) uttered more loudly. The notes

differ slightly in pitch from those recorded on the Fork River bed, Mackenzie Plains, in 1910. When the birds flew nearer, the *tsit* sounded on *g*. One plunged into the water, was under for about a second, and emerged uttering the cries of (6) very forcibly: the *keeahk* sounded like a cry of aggravation.

Addendum.

Mr. C. Howard Tripp, of Timaru, has been good enough to send the following note on tuis singing in harmony:—

"Though I was brought up close to native bush, and amongst native birds, particularly the tui, or parson-bird, I have only twice heard them singing in harmony, and have only met one other person who had also heard them. The first time was many years ago when camping in the bush up the gorge of the Orari River, when, shortly after sunrise in the summer holidays, about fifty or more tuis in the trees over and adjacent to our tent commenced to sing in most perfect harmony, and continued to do so for fully half an hour, and without leaving their perches. The second occasion was at the Orari Gorge homestead, a few years later, again on a bright sunny early summer morning; but then the harmony lasted for only about five minutes. As the bush near the Orari used to be favourite places for tuis, I have, of course, many times heard large numbers of tuis singing together, and have listened attentively for this harmony, but failed to hear it. Captain Cook, in his 'First Voyage,' describing Queen Charlotte Sound, writes as follows: 'The ship lay at the distance of somewhat less than a quarter of a mile from the shore; and in the morning we were awakened by the singing of the birds; the number was incredible, and they seemed to strain their throats in emulation of each other. This wild melody was infinitely superior to any that we had ever heard of the same kind. It seemed to be like small bells most exquisitely tuned, and perhaps the distance and the water between might be no small advantage to the sound.' Sir Walter Buller, I notice, in his noted book on 'The Birds of New Zealand,' quotes the above in the description of the makomako, or bell-bird. I am inclined to venture to doubt his correctness. If Captain Cook had spoken of slightly muffled bells I should have said that Captain Cook was listening to a similar harmony of tuis that I have heard twice, and not the makomako. You will notice that both the occasions I heard the harmony, and when Captain Cook did, was early morning. If any of the members have ever heard a similar harmony I would be much obliged if you would communicate with me."

I have not heard tuis singing in harmony in the way described by Mr. C. H. Tripp in the above note, but from the nature of many of the notes both of the tui and bell-bird it must often happen that, when numbers of the birds are singing, harmony will emerge from the body of sound. If the notes of such tui themes as (63) and (67) on page 389, Trans. N.Z. Inst., vol. 45, or such a bell-bird theme as (22) recorded in the present volume, be sounded, it will be found that they form perfect chords; so that however many birds were singing, and no matter in what sequence the different notes were sung by the different birds, the result must be harmonious, whether the birds intended it or not. Mr. Tripp inclines to the opinion that the birds heard by Captain Cook whilst lying in Queen Charlotte Sound were tuis, rather than bell-birds; but, so far as my limited

experience goes, they might have been either, or both in concert, for both have notes and themes to which Captain Cook's description might apply. Whilst much of the harmony heard is probably not produced intentionally, I think it quite as probable that occasionally it is intentional, for I have on one occasion heard a duet between a tui and a bell-bird, as recorded on page 666, Trans. N.Z. Inst., vol. 43. There was absolutely no doubt of the fact, for both birds were in view, sitting in the same tree, and the bell-bird repeatedly came in at the right moment—on the very beat. The tui sang his bell notes, and at once the bell-bird sang his theme to the bass of the tui's *aurr aurr*.

ART. LVII.—*Notes on* Nothopanax arboreum, *with some Reference to the Development of the Gametophyte.*

By ELIZABETH M. PIGOTT, M.A.

Communicated by Professor H. B. Kirk.

[*Read before the Wellington Philosophical Society, 28th October, 1914.*]

GENERAL NOTES.

CLOSELY allied to the order *Umbelliferae* is the order *Araliaceae*, differing from it chiefly in being arboraceous in habit and tropical in distribution, though it is found in Japan, Canada, north-west America, and New Zealand. Among other differences between the two orders is the presence of usually three or more carpels in the ovary. In *Schefflera digitata*, a New Zealand species, there are five carpels. This plant also bears its flowers in strongly scented racemes. In another New Zealand member of the order, however, *Nothopanax arboreum*, the appearance of three carpels, though not uncommon, is not usual: it usually produces only two. Moreover, the fruit does not, as in *Umbelliferae*, split up into separate mericarps, but remains somewhat fleshy when mature. The three orders, *Umbelliferae*, *Araliaceae*, and *Cornaceae*, agree in having the ovules solitary in each carpel. Bracts, also, are absent in *Nothopanax arboreum*, though, indeed, they are not always present in all members of *Umbelliferae*. There are no vittae in the seed.

LIFE-HISTORY OF NOTHOPANAX ARBOREUM.

Nothopanax arboreum usually begins life as an epiphyte on tree-ferns, though one was observed growing on the felled stump of a large timber-tree. Young seedlings are, however, quite able to grow on the ground, and frequently do so in nature when sufficient light is available on the ground. The plant was not observed to bear flowers while still an epiphyte. In the epiphytic trees roots are given off often at a great height. These seek the ground, clinging closely to their support. Later they completely envelope the host, as in rata, and when the host dies away the plant remains as a *Nothopanax* tree.

Juvenile Forms.

The mature fruit-bearing form has leaves 5–7-foliate, with serrate edges. The seedlings show, however, that, as in many other New Zealand plants, this condition is not the original one. The cotyledons are usually small and rounded (occasionally longer and narrower), with entire margins (fig. 1, A). These remain till eight leaves are formed. The first foliage eaves are unifoliate, and, though produced singly, can easily be regarded as pairs. They are larger than the cotyledons, and have serrate margins (fig. 1, A–E). Four other pairs of leaves are produced closely resembling these, but when the sixth pair is produced it is found to be trifoliate, the

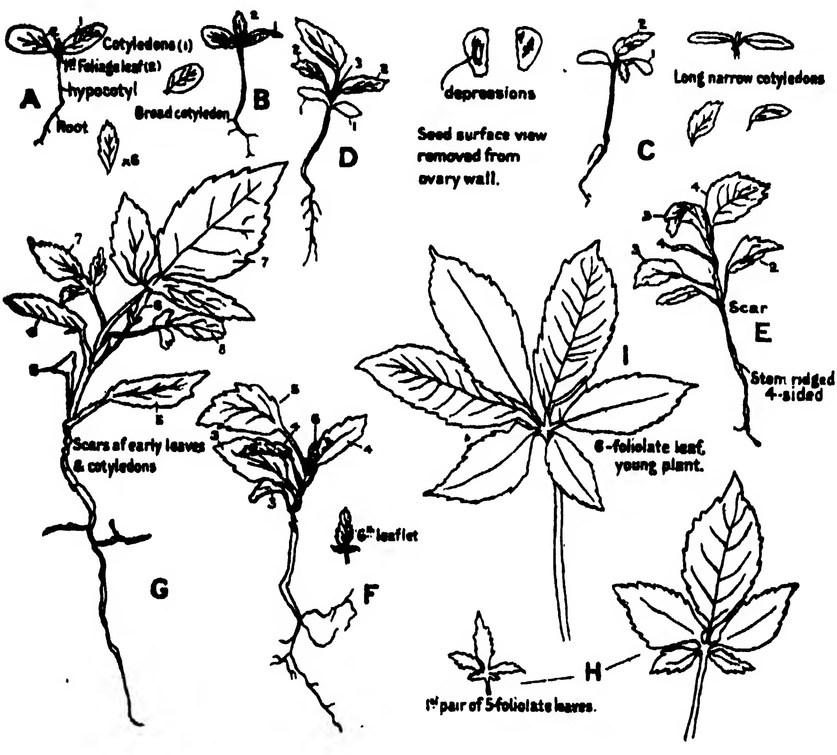


Fig. 1.—Stages in leaf-development in *Nothopanax arboreum.*

two lateral leaflets being much smaller than the terminal leaflet. The seventh and eighth pairs are also trifoliate (fig. 1, F–G). When the ninth pair appears it is seen to be 5-foliate (fig. 1, H). The terminal leaflet is the largest, and the two lowest the smallest, as in the trifoliate leaves. In the mature forms the leaves are 5–7-foliate, and this condition is attained at about this stage; some when they have achieved the 5-foliate condition do not alter further, others form 6- or 7-foliate leaves straight away (fig. 1, I). In the specimens examined the variations were for the most part constant, though in one or two the sixth pair of leaflets was normally trifoliate, the seventh returning to the unifoliate condition.

INFLORESCENCE.

The inflorescence of *Nothopanax arboreum* is composed of compound umbels, three times divided. These spring from the tips of the branches, and are shorter than the leaves. Quite often two peduncles spring laterally from below the origin of the others. The number of branches in each umbel is very irregular—the primary peduncles numbering from twelve to fifteen, the secondary branches from fifteen to thirty, and the actual flower-pedicels from five to fifteen. Though very irregular in number, these stalks are very uniform in length. In some of the male trees examined the peduncles and pedicels were much flattened.

MALE TREE.

The plant is dioecious, male trees bearing brown rounded buds with five microscopic sepals, five petals, five stamens, and a gynoecium with two carpels and two style-arms. The petals, which are valvate in the bud, are brown on the outer surface and greenish-brown on the inner, small, and pointed. The stamens have large anthers packed upright in the buds, and there are corresponding depressions in the disc to accommodate their bases. They alternate with the petals. The style-arms are two, upright in the bud, small and thick, which diverge when the flower opens. The buds are protected in the young stage by masses of colourless mucilage, which later falls away. This is said to arise from hairs which are developed with the flower-buds. In about three months (April–June) from their first appearance the buds open. The petals expand like a star, the filaments of the stamens lengthen considerably till about as long as the petals, and the stigmas diverge somewhat. They possess a red colour, which was also seen while in the bud.

POLLINATION.

The flower soon becomes distinctly scented, and small quantities of nectar are seen on the disc. They are then visited by blow-flies, and very occasionally by bees. The latter, however, on account of the length of the proboscis, cannot make use of the nectar. A short time after the opening of the flower the ovaries become compressed, and often much deformed. When all the pollen is shed, an absciss layer is formed at the base of the receptacle, and the flower is cast off. Later the pedicels and peduncles are also cut off. The ground below male trees becomes strewn with flowers, especially after rain.

On one male tree examined there was found an umbel of seven well-formed fleshy fruits, with two seeds each. Also, later in the season (September), when the crop of male flowers had all fallen, an inflorescence of hermaphrodite buds was found on the same tree.

Compression of the receptacle is accompanied by a swelling in the ovary-wall, but the ovule itself withers before the flower falls.

FEMALE TREES.

On female trees the buds are compressed from very early stages, and consist of an enlarged receptacle enclosing the ovary and a small perianth-cap consisting of five microscopic sepals, five petals (smaller than those of the male plant), usually five staminodes (though it is not uncommon to find that there are four or only three formed). These staminodes have very

short thick filaments and two anther-lobes as in the stamens of the male flower. Certain cells are seen, under the microscope, to form mother cells of the pollen-grains but in no case examined were actual pollen-grains formed.

The gynoecium in the female flower consists, as in the male flower, of two carpels each with a single ovule and two style-arms. Sometimes buds with three carpels are found. The ovary is then triangular, with slight depressions between the ridges. In the flowers with two carpels the ovary is compressed. In one tree observed the buds and fruit were mottled, green and brown, while in all others they were brown, the colour being constant for each tree.

Opening of Flower.

When the flower is about to open, one of two methods is adopted: either the perianth is shed without opening as a cap—that is almost invariable in the mottled variety—or the petals may open as in the male flowers. Enclosed within the perianth-cap thus shed are the staminodes. When the petals are spread they do not persist, the typical flower consisting only of sepals and the gynoecium. The two stigmas diverge shortly after the flower opens, and the petals are smaller than those of the male flower. In the female flower there is no scent; nor have any insects been seen visiting the flowers in search of nectar or pollen, though nectar is produced in small quantities. Occasionally there are three carpels, with the corresponding styles and stigmas. The ovary is then triangular. Intermediate stages were often noted in which there were three carpels, but only two well-formed styles, the third being nearly abortive. In others, again, only two carpels were formed, with their respective styles, occupying positions as in the trilocular ovary. This seems to bear on the gradual evolution of the *Umbelliferae* among the *Archichlamydeae* making for combined simplicity of structure and effectiveness in achieving pollination.

An article on "Floral Evolution" which appeared in the *New Phytologist*, vol. 10, April, 1911, p. 113, points out the importance of progressive reduction in the number of ovules in each carpel. In *Umbelliferae* the climax of economy is reached in the invariable production of one ovule only for each carpel. The article goes on to show the importance of floral aggregation in economy, and also of the inferiority of the ovary. In the matter of aggregation and in bicarpellarity of the ovary *Nothopanax* seems to mark an advance on another member of its order, *Schefflera digitata*. In the matter of insect-visits it does not appear to have attained any distinction.

In the female flower of *Nothopanax arboreum* the disc may grow up as a conical structure, but usually it remains more or less flat. Pollen-grains have been seen on the stigmas and in the axils of the pedicels and peduncles. In some cases the grains were undoubtedly those of *Nothopanax arboreum*, but in no case was a pollen-grain seen to germinate. No nectar is produced in the conical-disced flowers; there is, therefore, little or no apparent reason why insects should visit the flowers.

The plant is the food plant of the caterpillar of a moth, *Declana artronivea*. This caterpillar is mottled like the fruit among which it lives, and is therefore protected from attack, being very difficult to detect. On the trees bearing brown fruit a very similar brown caterpillar was found. Being unable to move from tree to tree, the caterpillar cannot assist in pollination.

All the flowers of the inflorescence are of the same value and structure both in male and in female plants. In this respect *Nothopanax* differs

from many of the *Umbelliferae* which have reached the advanced stage of having hermaphrodite and unisexual flowers in the same umbel. There the hermaphrodite flowers open before the unisexual (male) ones of the same umbel. In *Nothopanax arboreum* the outer flowers of the umbel open first. Geitonogamy is here not possible, as the pedicels separate the flowers too much.

POLLEN.

The pollen-grains are boat-shaped, with three radiating grooves. A few experiments were made with the pollen-grains. An attempt was made to pollinate the male flowers (pseudo-hermaphrodite) with pollen from their own stamens, with pollen from stamens of adjacent flowers of the same umbels, from different umbels, and from different trees—with no result. All fell at about the same time as the other male flowers.

Several attempts were also made to germinate the pollen-grains in a sugar solution of about 10 per cent., but none was successful.

Flowers of the female tree were also protected with muslin to ensure against external pollination. Only one of these bunches remained, held by a thread of cotton, and in it the flowers had one and all withered and fallen. The other bunches had, apparently, all fallen. The flowers are evidently cross-pollinated. Their own stamens being functionless, these flowers exhibit physiological femaleness.

Some of the hermaphrodite buds found on the male tree were protected while yet unopened, several of them being under one enclosure. These opened and formed the early stages of fruit while under the muslin quite as well developed as those outside. Of these hermaphrodite buds, three or four only had withered, as had also some of those unprotected, confirming the opinion that some few were pseudo-hermaphrodite male flowers as the normal flowers on the tree, which they closely resembled. These hermaphrodite flowers all opened and spread their petals and stamens. The filaments were shorter than those of the male flowers. Both petals and stamens were cast off later, leaving the flower with the characteristic appearance of the female flower. There is the difference here, however, that pollen-grains are actually formed.

There is no definite arrangement of hermaphrodite and unisexual flowers in the umbels. In those umbelliferous plants in which there are pseudo-hermaphrodite male flowers and true hermaphrodite flowers—*e.g.*, Venus's comb—the latter open first, the former not until the latter have cast their stamens and petals. Directly the petals open in these hermaphrodite flowers, a finely granular honey-secreting disc and two short styles are revealed in the centre of the flower. The stigmas mature, but the stamens are incurved like hooks.

The fruit of the previous season remains on the tree for some time after the flowers open. Later it falls in whole clusters, though the individual fruits are easily detached. The receptacle is enlarged and fleshy, and contains two seeds protected in a hard pericarp.

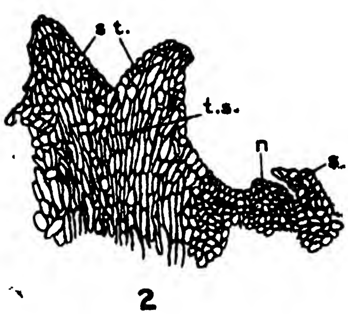
STAMENS.

The anthers are large and versatile, 2-lobed, with two pouches to each lobe. Dehiscence takes place by longitudinal slits. The inner cells of each lobe are highly granular and protoplasmic. They become free from their neighbours while still enclosed in their cell-walls. Each mother cell forms a tetrad of pollen-grains, which are finally liberated

in the anther-sac. They are three-sided in cross-section, and have, when ripe, a pale-yellow colour. The external wall is marked by regular sculpturings, in addition to three prominent longitudinal ridges. The cells bordering the connective tissue and the epidermis do not form mother cells, but form the tapetum—a layer which becomes disorganized, helping in the development of the pollen-grains. Each pollen-grain consists of two cells, with clear nuclei, which can occasionally be seen through the walls. Development here is the typical development of a dicotyledon. In the male flowers the anthers are yellow, but in the female flower the staminodes never lose their greenish colour. The anthers become broken off, and often all that is left is a portion of the thickset filament alternating with the petals.

Stigmas.

The stigmas are bifid, the outer surface of each lobe being protected by a continuous epidermis. The inner surfaces, however, on diverging, present a slightly papillate stigmatic surface (fig. 2). The cells immediately below the stigmatic surface are vertically long and narrow, with thin walls, and are loosely packed. In many sections this tissue tended to break down, owing to its delicacy. It thus facilitates in every way the entrance of a pollen-tube; yet in no case was one seen, even when pollen-grains were observed on the stigma. The style-arms, still in their divergent position,



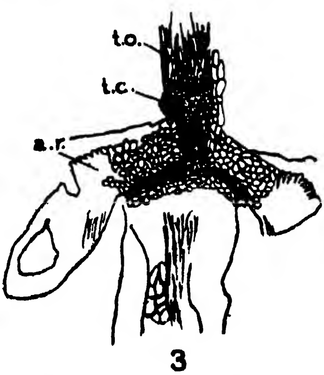


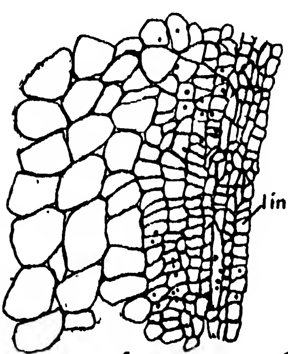
Fig. 2.—Stigmatic surfaces and tissue of style of mature fruit. × 175.
Fig. 3.—Longitudinal section of portion of young fruit, showing ⊥-shaped mass of thick-walled tissue at the base of the style. × 28.

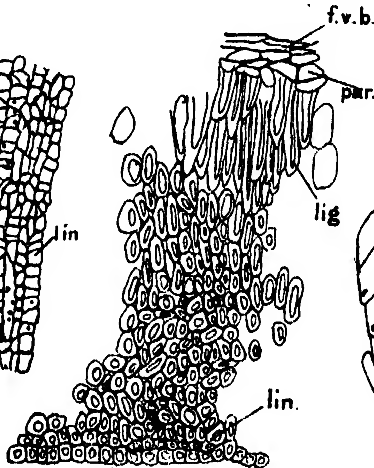
persist through the formation of the fruit, but are, of course, relatively much smaller. The tissues of these arms, surrounding the central column of long cells, comprises a cylinder of loose irregular cells. In some cases the tissue below the style was of thick-walled regular cells, the thickening being of cellulose. The characteristic shape of this mass of tissue was that of an inverted stool, the disc extending towards the funicles of the ovules. This tissue was not observed till after the earliest stages in the development of the endosperm (fig. 3).

Ovary-wall.

Very shortly after the male flowers have all fallen the ovary of the female flower begins to increase greatly in size, and microscopic examination showed that the cavity of the ovary is lined in the young flowers and buds

of both male and female plants by transversely elongated cells, rectangular in longitudinal section. These cells are at first from five to nine layers deep, but the number of rows increases with further development, extending almost to the axial bundle in the fully grown fruit. In the young buds and flowers the carpels are seen to be oval in cross-section. Soon, however, this shape is altered, owing to the appearance of longitudinal ridges traversing the cavity on both sides near the middle. The cavity is thus almost divided into two compartments, and presents a dumb-bell shape in cross-section. In the male flower this wall does not achieve any great thickening of its cell-walls, although the ridges are formed (fig. 4). In the female flower the ovary-wall gradually thickens its cell-walls, which later become extremely hard and wooden (fig. 5). The cells are fairly regular in shape and position, being arranged in rows. In the thin-walled stage they have protoplasmic contents, and usually a single nucleus, though occasionally two or more have been noticed. The end walls of these cells are at right angles to the lateral walls, although, at the curves in the ovary-wall, from





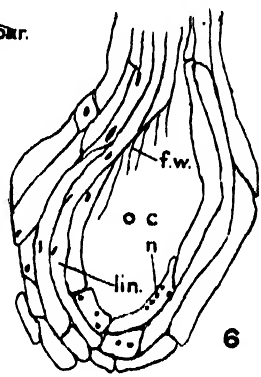


FIG. 4.—Longitudinal section of ovary-wall in young male and female flowers with unthickened cell-walls. × 175.

FIG. 5.—Longitudinal section of ovary-wall in mature fruit with much-thickened cell-walls. × 175.

FIG. 6.—Cross-section of developing ovary-wall, showing frayed cell-walls and multinucleate cells. × 175.

the irregular manner in which the cells here fit into each other, the ends appear to be more or less tapering. These long cells of the wall are interrupted by columns of parenchyma cells at the outer edges, and at the axis connecting the two carpels, running between the two branches of the axial fibro-vascular bundle. Near the top these parenchyma cells extend right to the cavity of the ovary, but for the greater part of the length of the ovary at least one layer of woody cells is continuous. As the cavity enlarges, the inner layers of cells become stretched to their utmost capacity, and are often frayed in the process (fig. 6). In the mature ovary the only discontinuity in this wall is seen at the origin of the funicle and arillus, where their place is taken by large-celled parenchyma.

In the female flower, even in cases where one ovule is aborted, the wall becomes thickened, though no stage has been noticed in which it has done so if neither of the ovules matured. Some of the flowers had withered and fallen, from no apparent mechanical injuries, and this pointed to the conclusion that when neither of the ovules reached maturity the flower was cast off by an absciss layer being formed at the base of the pedicels.

Ovule.

Coming now to the development of the ovule, we find a pendulous ovule, the funicle arising from the axial placenta, not, as at first appears, from the top of the ovary. The ovules turn from each other, as is usual. In the young buds examined the ovules had not completely achieved the anatropous condition typical of the mature form. The micropyle is in these young stages seen to be wide, and situated laterally, being almost at right angles to the funicle. Later, by unequal growth of the cells of the funicle, the ovule becomes truly anatropous. The micropyle is then almost entirely roofed over by the arillus, a structure arising from the funicle. This in the young bud is as large as the body of the ovule itself, and presents there a rounded bulgy appearance (fig. 8). Its cells are larger than those of the funicle from which it springs. As the flower develops, the cells of the arillus are seen to acquire a radiating appearance, while the outer cells become papillate (fig. 16). As the ovule reaches maturity these cells collapse and the whole structure degenerates. It does not increase much in size throughout the life of the ovule. It is present in both male and female flowers, and is also seen in the hermaphrodite flowers. Here it has not the rounded character, as in the male and female flowers, formed earlier, but it is more gently sloping. In the female flower it completely overarches the micropyle of the ovule, its papillate cells seeming to lead to the micropyle.

Integument.

As in *Umbelliferae* generally, there is only one integument. In the young ovule it is seen on both sides of the nucellus, from which it is entirely

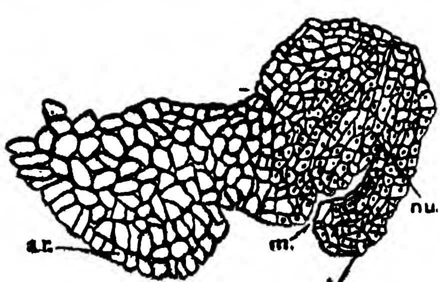


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Fig. 7.—Longitudinal section of ovule in male bud, showing crescent-shaped integument. × 175.

Fig. 8.—Longitudinal section of ovule in male bud, showing arillus and undifferentiated nucellus. × 175.

free, leaving a very wide micropyle. In some male buds sectioned the arillus formed the largest part of the ovule, the integument being scantily developed and crescent-shaped in longitudinal section (fig. 7). Later the

integument grows up, and encloses the nucellus while yet an undifferentiated mass of cells, leaving the micropyle now long and narrow (fig. 8). The integument where it borders the funicle becomes very closely connected with it. The cells are angular, deeper above the nucellus than at the sides. In the young ovule the integument constitutes a large proportion of its size, but when endosperm begins to be formed, and the ovule increases greatly in size, the integument becomes thinner, and spreads over the surface of the rapidly growing ovule. The body of the ovule undergoes many contortions, forming invaginations always lined by the integument. The ovule has thus a very large surface area compared to its volume. Two chief and characteristic invaginations correspond to the ridges in the ovary-wall. There are, however, other smaller invaginations with which there seems to be no correspondence in the wall of the ovary.

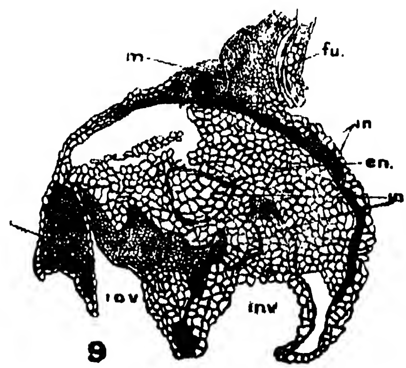


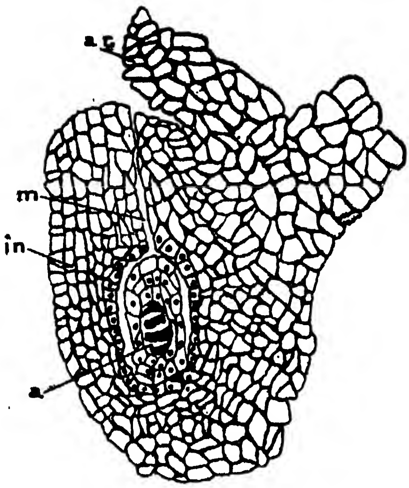
FIG. 9.—Longitudinal section (slightly tangential) of ovule, showing general effect of the invaginations of ovule-walls. × 28.

Soon the micropyle gives the appearance of being plugged up by the integument, though this may be due to an invagination immediately below it. The cells of the integument are small, and, in the young ovule, uniform in size. During development, however, there are seen one or two layers of much larger, thin-walled cells between the ordinary cells of the integument and the nucellus. These are interrupted at the base, and do not extend quite to the micropyle. They form, therefore, a hollow irregular cylinder open at both ends. These cells are irregular in shape. Their origin was not determined (fig. 13). The demands made upon the integument in the growing ovule by the formation of so many invaginations are quite sufficient to explain its rapidly increasing thinness (figs. 12 and 17). In ovules in which endosperm has been fully formed, the integument consists of cells of two kinds—large outer cells, usually one or occasionally two cells deep. These are turgid, and contain a diffuse green colouring-matter. The inner cells are several cells deep, regular in outline, and with dense protoplasmic contents. The large cells before mentioned (fig. 12) render the connection between the integument and endosperm easily severed, and the two can be easily separated under the dissecting-microscope when the endosperm has reached the "milky" stage. The integument in the seed is brown, and consists of a single layer of large cells (fig. 21). When the section is through the floor of an invagination the cells of the integument are seen to be large and regular. In the seed (when it has been removed from the wall of the ovary, which breaks away from the tissue of the receptacle to enclose it) there are seen to be two chief invaginations.

NUCELLUS.

The nucellus consists at first of an undifferentiated mass of cells loosely surrounded by the integument. The next stage obtained in sectioning was the archesporial stage, in which a central cell of the nucellus had divided

into a tier of four cells not separated by cell-walls (fig. 10). Both ovules in the bud showed exactly the same stage in development. This stage was also seen in other buds, but all were male. No corresponding stage was observed in female buds of the same date. The female buds also showed that both ovules were at the same stage in development until the opening of the flowers, when often one is aborted. In flowers with three carpels one or two may be aborted or all may mature. In any case, all the carpels are developed, and the fruit appears normal externally.



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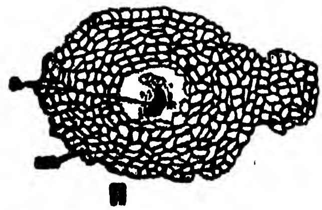


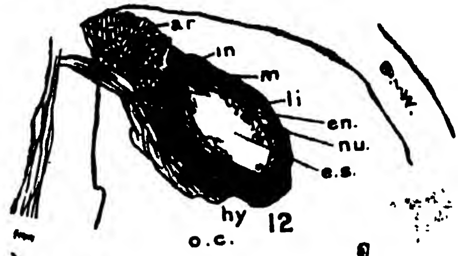
FIG. 10.—Longitudinal section of ovule in male flower. Archesporium. × 175.
FIG. 11.—Cross-section of same stage. × 175.

The nucellus finally consists of a single row of cells, regular and rectangular in both cross and longitudinal sections. It is drawn up, the micropyle leaving the embryo-sac exposed. The contents of the embryo-sac in these early stages were not made out. There was, however, a possible indication of synergidae and a probable ovum, though there was no appearance of antipodal cells.

HYPOSTASE.

At the base of the embryo-sac, supporting it and interrupting the nucellus, was found a funnel-shaped structure consisting of cells resembling those of the nucellus, but staining less deeply with Erhlich's acid haematoxylin. They had clear walls and large nuclei (figs. 12 and 13). This structure was identified with the hypostase which Van Teighem notes in *Rosaceae* and allied polypetalous dicotyledons. He says, "It consists of a small cupule of isodiametric cells which have strongly lignified but not much thickened membranes, and is found in the nucellus below the embryo-sac, its object being to arrest the longitudinal growth of the embryo-sac and endosperm towards the base of the ovule. Owing to its strong lignification, it resists the various diastatic agencies at work during the formation of the embryo and endosperm, and for the same reason is incapable o- growth. Hence it appears in the ripe fruit exactly as in the pistil, but, being relatively much smaller, it is difficult to find. By arresting the basal de-

velopment of the endosperm it protects from destruction the region of the nucellus between itself and the chalaza. This in the ripe seed is intercalated between the integument and the endosperm or embryo. Hence in those cases a greater or less amount of perisperm is formed."



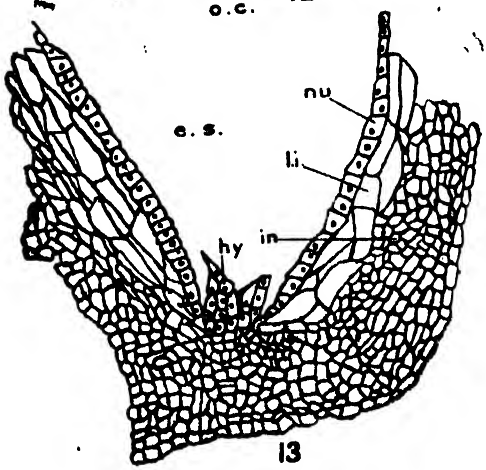


FIG. 12.—Longitudinal section of embryo-sac, showing position of hypostase and large inner cells of the integument, arillus, and relative size of the ovule and ovary-cavity near the beginning of the formation of endosperm. × 28.

FIG. 13.—Lower portion of 12. × 175.

The hypostase found in *Nothopanax arboreum* was traced for some time after the formation of endosperm, but was lost sight of later, and could not be seen in the seed. In many radial longitudinal sections in the endosperm stage the hypostase could not be seen at all.

EMBRYO-SAC.

Many intermediate stages in the development of the embryo-sac were missed, owing to the extreme difficulty of sectioning the hard-walled ovary with the ovule *in situ*. Every precaution was taken. In the younger ones the base of the ovary-wall was cut immediately and before fixing. Later, when the ovule had achieved full size, it was removed from the ovary, and fixed in acetic acid, in place of osmic chromic formerly used. A vacuum process was also adopted. The results were, on the whole, better.

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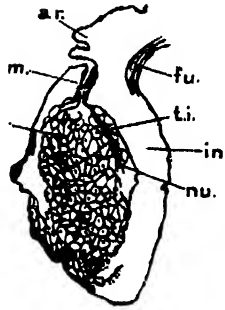

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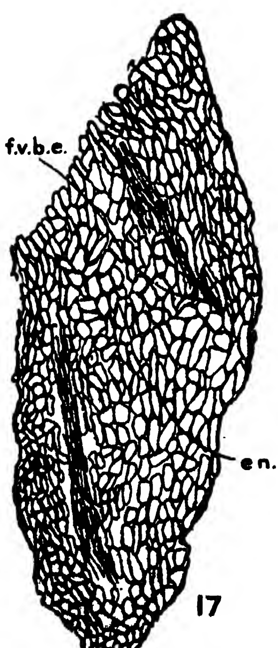
FIG. 14.—Longitudinal section of embryo-sac (female flower), showing early stages in development of endosperm before the appearance of an embryo. × 175.

FIG. 15.—Longitudinal section of ovule (female flower), showing continuous endosperm and no embryo. × 28.

FIG. 16.—Longitudinal section of ovule (female flower), showing early invaginations of integument, also arillus. × 28.



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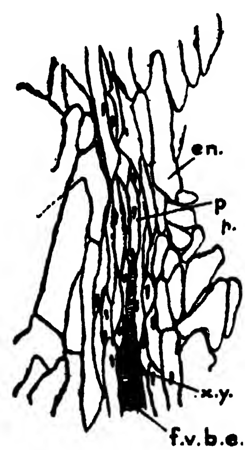

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FIG. 17.—Longitudinal section of ovule, showing fibro-vascular strands traversing the endosperm. × 28.

FIG. 18.—Fibro-vascular strand. × 175.

ENDOSPERM.

The early stages in the development of endosperm were seen, in which the nuclei had become scattered through the vacuolate protoplasm. Later, cell-walls were formed about them (fig. 14). By successive division of the cells a dense endosperm is finally formed. This endosperm is continuous through a number of consecutive sections both radial and tangential, the only visible discontinuity being a very small break just below the micropyle in one section (fig. 11). There was no appearance of any embryo in any of these sections. It thus seems that here we have the formation of continuous endosperm before any pollination was observed and before the appearance of any distinct embryo.

In several cases of endosperm viewed under the dissecting-microscope there was the appearance of fibro-vascular strands traversing the endosperm. This was also confirmed in several ovules sectioned. The fibro-vascular strand is branched, and consists of annular xylem elements and phloem elements with large elongated nuclei and square ends to the cells. The fibro-vascular bundle of the funicle has annular vessels and phloem elements, but no connection was established between the two (figs. 17 and 18).

EMBRYO.

At the earliest stage at which an embryo was observed it already consisted of several cells—five to seven concentric rings of regular cells wholly embedded in the endosperm (figs. 19 and 20). It was very small, and was

FIG. 19.—Longitudinal section of ovule, showing embryo (*e*) immersed in endosperm. × 28.
FIG. 20.—Longitudinal section of embryo. × 175.

situated near the funicle, though whether at the micropylar or antipodal end is uncertain owing to the complete disappearance of the micropyle. In *Umbelliferae* generally, the hypocotyl points to the top of the ovule; in

Nothopanax arboreum the cotyledons, borne on the lengthening hypocotyl, point towards the integument where it is nearest, and away from the funicle.

A cross-section of the embryo of the seed shows the cotyledons, which are concave on their inner surfaces, and the body of the embryo showing delicate cell-walls, which are not clearly defined. In a seed which had lain

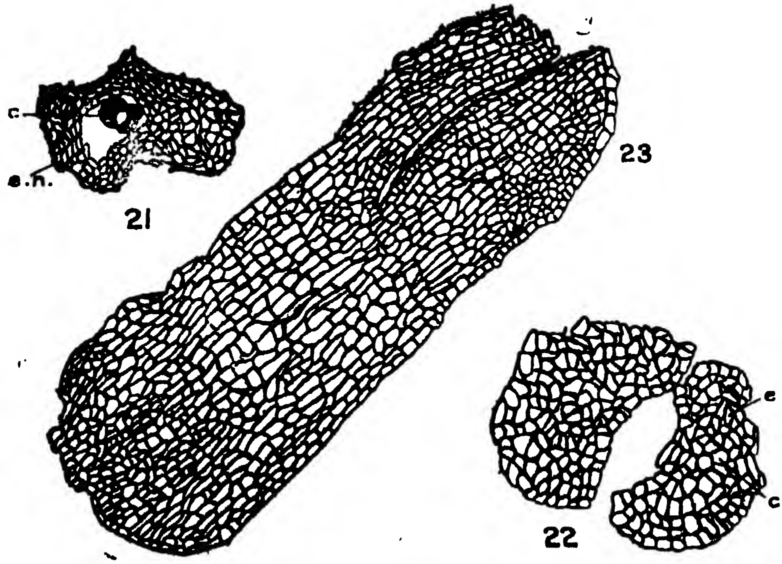

Fig. 21.—Cross-section of seed with embryo. × 28.
Fig. 22.—Cross-section of embryo cotyledons. × 175.
Fig. 23.—Longitudinal section of embryo from seed. × 175.

in the ground apparently for a whole season, and was found among seedlings, the ovary-wall pericarp was softening, but the embryo had achieved no very great size. Seeds which were planted for three months showed no signs of germination.

EXPLANATION OF LETTERING IN FIGURES.

- *a.* archesporium.
- *ar.* arillus.
- *c.* cotyledons.
- *e.* embryo.
- *e.s.* embryo-sac.
- *en.* endosperm.
- *fu.* funicle.
- *f.w.* frayed walls of broken-down lining cells.
- *fv.b.* fibro-vascular bundle.
- *fv.b.e.* fibro-vascular bundle in endosperm.
- *hy.* hypostase.
- *in.* integument.
- *inv.* invagination.
- *l.i.* large cells in integument.
- *lig.* obliquely placed cells with lignified walls.
- *lin.* cells lining cavity of ovary.
- *m.* micropyle.
- *n.* nucleus.
- *nu.* nucellus.
- *o.c.* ovary-cavity.
- *o.w.* ovary-wall.
- *p.* phloem.
- *par.* parenchyma cells.
- *s.* sepal.
- *st.* stigmatic surfaces.
- *t.s.* tissue of style.
- *xy.* xylem.

ART. LVIII.—*Record of Borings at Horotiu, near Ngaruawahia.*

By J. R. HETHERINGTON.

Communicated by D. Petrie, M.A., Ph.D.

[*Read before the Auckland Institute, 16th December, 1914.*]

HOROTIU is seventy-eight miles south of Auckland, and the railway-station there is 78 ft. above sea-level. Four separate bores were sunk in the hope of discovering workable coal-seams. They were located at spots generally about 20 ft. below the level of the railway-station. Bores 1 and II reached a depth of 446 ft. and 450 ft. respectively. The latter ended at an old beach formation filled with well-preserved marine shells. The data given below belong to Bores III and IV, which were put down on Mr. Gallagher's land. Bores 1 and II gave off abundant inflammable gas, and also threw up water at a high pressure.

BORE No. III. (The depths are in feet and inches.)

Ft.	in.		Ft.	in.	
	..		0	6	Black soil.
0	6	to	2	6	Subsoil.
2	6	,,	8	6	Shingle.
8	6	,,	23	6	Sand.
23	6	,,	28	6	Firm white pumice.
28	6	,,	48	6	White clay and swamp mixed.
48	6	,,	51	10	Sand.
51	10	,,	81	0	Blue fireclay and shingle.
81	0	,,	93	0	Hard pumice.
93	0	,,	103	0	Swamp and timber.
103	0	,,	117	0	Hard sandstone.
117	0	,,	120	0	Brown fireclay.
120	0	,,	129	0	Sand.
129	0	,,	139	0	Pumice.
139	0	,,	172	0	Light fireclay.
172	0	,,	176	0	Dark fireclay.
176	0	,,	181	0	Brown fireclay.
181	0	,,	212	0	Blue fireclay and marl.
212	0	,,	226	0	Sandstone.
226	0	,,	244	0	Running sand.
244	0	,,	265	0	Blue fireclay.
265	0	,,	265	6	Very hard sandstone.
265	6	,,	273	6	Blue fireclay and marl.
273	6	,,	278	6	Lignite.
278	6	,,	349	0	Blue fireclay.
349	0	,,	360	0	Blue fireclay and poor coal.
360	0	,,	366	0	Very soft mud.
366	0	,,	400	0	Sand.
400	0	,,	408	0	Blue fireclay and poor coal.
408	0	,,	416	0	Blue fireclay.

Bore No. III—*continued.*

Ft.	in.		Ft.	in.	
416	0	to	430	0	Brown fireclay.
430	0	„	433	0	Lignite.
433	0	„	435	0	Very soft sand and mud.
435	0	„	468	0	Blue fireclay.
468	0	„	473	0	Coarse sand.
473	0	„	480	0	Brown fireclay.
480	0	„	532	0	Blue fireclay and lignite.
532	0	„	543	0	Strata of sand and soft country.
543	0	„	552	0	Blue fireclay and lignite.
552	0	„	573	0	Very soft sand and mud.
573	0	„	610	0	Lignite and soft mud.
610	0	„	640	0	Sandstone.

Bore No. IV. (Record starts at 640 ft., the strata above being the same as in Bore III.)

Ft.	in.		Ft.	in.	
640	0	to	643	0	Sandstone.
643	0	„	687	0	Soft running sand.
687	0	„	688	0	Stratified sandstone.
688	0	„	700	0	Blue fireclay.
700	0	„	714	0	Brown fireclay.
714	0	„	735	0	Sand.
735	0	„	740	0	Brown clay.
740	0	„	752	0	White clay.

PROCEEDINGS.

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE, 1914.

TWELFTH ANNUAL MEETING.

WELLINGTON, 29TH JANUARY, 1915.

THE annual meeting of the New Zealand Institute Board of Governors was held in the Parliamentary Buildings on Friday, the 29th January, 1915, at 10 a.m.

Present: Professor C. Chilton, President (in the chair), Dr. L. Cockayne, Professor Easterfield, Mr. C. A. Ewen, Professor Farr, Dr. Hatherly, Mr. H. Hill, Professor Kirk, Professor Marshall, Mr. D. Petrie, Professor Segar, Mr. R. Speight, Mr. G. M. Thomson, Dr. Allan Thomson, Mr. A. H. Turnbull, and Mr. K. Wilson.

Change in Representation.—The Secretary announced that the only change in the representation on the Board was that caused by the election of Professor Segar as representative of the Auckland Institute in place of the late Mr. James Stewart.

Apologies for Non-attendance.—Apologies for non-attendance were received from the Hon. H. D. Bell, Minister of Internal Affairs, and from Professor von Zedlitz.

The late Mr. Stewart.—On the motion of Mr. D. Petrie, seconded by Mr. H. Hill, it was unanimously resolved that the Board of Governors of the New Zealand Institute record their appreciation of the services to the Institute of the late Mr. James Stewart, C.E., of Auckland, and express their regret at his loss.

President's Address.—The President then read his annual address. (See p. 626.)

Reports of the Incorporated Societies.—The annual reports of the incorporated societies were laid on the table.—Received.

Standing Committee's Report.—The annual report of the Standing Committee was received, as follows :—

REPORT OF STANDING COMMITTEE.

Five meetings of the Standing Committee have been held during the past year, the attendance being as follows: Professor Chilton, 4; Dr. Cockayne, 4; Professor Easterfield, 4; Mr. Ewen, 2; Mr. Hill, 1; Professor Kirk, 4; Professor Marshall, 1; Dr. Petrie, 1; Mr. Stewart, 1; Mr. G. M. Thomson, 2; Dr. Allan Thomson, 2; Mr. Turnbull, 1; Mr. Wilson, 1; Professor von Zedlitz, 4.

Hector Memorial Award.—The presentation of the medal to Mr. Elsdon Best took place in the Town Hall, Wellington, on the 5th September, 1914, the President, Professor Chilton, making the presentation.

Deed of Trust.—The alteration of the Hector Memorial Deed of Trust to make it rigidly conform to the conditions laid down by the Hector Memorial Committee when handing over the fund to the New Zealand Institute has now been completed. The firm of Chapman, Skerrett, Tripp, and Blair submitted a draft of the proposed amended deed, which was referred to a sub-committee, consisting of Professors Easterfield and von Zedlitz, who reported to the Standing Committee on the 27th June, 1914, as follows :—

"The Committee set up to report on the letter dated the 20th March from the firm of Chapman, Skerrett, Tripp, and Blair, and the draft resolution enclosed therewith, beg to report as follows :—

"1. The latter part of the letter in question made it appear that in the opinion of the legal expert the Governors were to take into consideration the scientific work done in some particular year. Mr. Skerrett has been further consulted on this point, and in a letter dated the 1st May makes it clear that the investigation in any particular subject, so as to qualify for the prize, may take place in any year or number of years preceding the year in which the prize is awarded.

"2. The Committee has carefully compared the draft resolution amending the regulations and the draft deed of covenant submitted by the Institute's legal advisers with the conditions imposed by the Hector Memorial Committee before the funds were vested in the Institute. They detected certain minor discrepancies, and suggested to Mr. Skerrett that these should be rectified. Mr. Skerrett agreed to this in his letter of the 1st May, 1914, and the committee is now of opinion that the deed should be executed."

The amended deed was duly executed by the President and the Public Trustee on the 31st July, 1914.

Hutton Memorial.—The presentation of the Hutton Memorial Medal to the recipient for the year 1914, Dr. L. Cockayne, F.R.S., was made at the same time as the Hector Medal. The research grants made at the last annual meeting to Messrs. Hilgendorf (£10) and T. Hall (£20) were duly paid.

Publications.—Volume 46 of the "Transactions of the New Zealand Institute" was issued on the 15th June, 1914, and was laid on the table of the House of Representatives and that of the Legislative Council on the 23rd July, 1914.

Bulletin No. 3, Part II, "Studies in the Bryology of New Zealand," by Mr. H. N. Dixon, was issued on the 7th September, 1914.

Bulletin No. 1, Part II and Part III, "Description of New Genera and Species of *Coleoptera*," was issued on the 20th May, 1914. Part IV is now in the press.

Finances of the Institute.—The incorporated societies have been duly circularized in connection with the motion of the Hon. Treasurer, Mr. C. A. Ewen, at the last annual meeting, which reads, "That, in terms of Regulation 5, section (*e*), the Institute, on and after this date, will require from each of the incorporated societies a contribution of 2s. 6d. per member," to which motion Professor Marshall moved the following amendment, which was carried: "That the question raised in the motion be referred to the different Institutes for consideration and report." Replies of a favourable nature have already been received from the Otago Institute and the Wellington Philosophical Society.

British Association Reception Committee.—Arrangements had been made to publish, in co-operation with the Reception Committee, the proceedings of the Congress, but, as it was found impossible to hold the meetings, no further action was taken. A report of the Committee will be published elsewhere.

Decisions of the Standing Committee.—The only other decision of the Standing Committee that is of any importance is that the amount of the Hector Prize for 1914 shall be £45.

Annual Reports of Societies.—The annual reports and balance-sheets of the following societies have been received: Auckland Institute, to 19th February, 1914; Manawatu Philosophical Society, to 31st October, 1914; Philosophical Institute of Canterbury, to 31st October, 1914; Wellington Philosophical Society, to 30th September, 1914; Nelson Institute (Scientific and Literary Branch), to 31st March, 1914; Wanganui Philosophical Society; and Hawke's Bay Philosophical Institute.

Panama-Pacific Exposition at San Francisco.—An exhibit of all the publications of the Institute available, and those of the Canterbury Philosophical Institute, was got together and handed over to the Secretary to the New Zealand Government Commissioner to the Panama Exposition for exhibition in the New Zealand Pavilion.

Memorial to the late Mr. Hamilton.—The Wellington Philosophical Society early last year undertook to collect funds for the erection of a memorial to the late Mr. Hamilton, Director of the Dominion Museum, and at the last meeting of the New Zealand Institute Board of Governors the action of the Wellington Philosophical Society was approved. The committee appointed by the Council of the Wellington Philosophical Society to deal with the matter now reports that the sum of one hundred guineas is in hand, and has ascertained from Mr. Harold Hamilton that the wishes of the family are that a stone should be erected on the grave at Russell. A plain monolith of Whangaroa basalt is suggested, with a reference thereon to the late gentleman's keen interest in the Maori race.

Leave of Absence.—During the year some changes were necessitated through leave of absence being granted to the Hon. Treasurer and the Secretary, to enable them to visit England. Professor G. W. von Zedlitz kindly undertook to carry on the duties of Hon. Treasurer, and Dr. J. Allan Thomson acted as Hon. Secretary, and Mr. Leighton was Assistant Secretary for six months.

Numbers of Volumes of the Transactions in Stock.—During the year the custodian has taken careful stock of the immense number of Transactions now stored in the cellar of the Parliament Buildings, as well as a small number kept in the Museum for current sales and exchange. The labour of turning over, examining, counting, and storing this number of books, each weighing a few pounds, will be appreciated when it is seen that the total amounts to 15,041 volumes.

The following is a complete list of the Transactions in stock:—

Volume.	Number of Copies.	Volume.	Number of Copies.
1	349	24	549
2	Nil	25	532
3	"	26	597
4	"	27	699
5	26	28	664
6	6	29	565
7	135	30	659
8	14	31	702
9	170	32	679
10	188	33	617
11	411	34	586
12	330	35	445
13	137	36	532
14	104	37	289
15	232	38	191
16	319	39	212
17	474	40	46
18	295	41	163
19	485	42	165
20	428	43	47
21	495	44	58
22	510	45	73
23	590	46	273

The report was considered and adopted.

Hector Deed of Trust.—On the motion of Mr. G. M. Thomson, seconded by Mr. K. Wilson, a hearty vote of thanks was passed to Messrs. Chapman, Skerrett, Tripp, and Blair for the legal services which they have gratuitously rendered to the New Zealand Institute in connection with the Hector Deed of Trust.

Financial Statements.—The Hon. Treasurer (Mr. C. A. Ewen) presented his statement of receipts and expenditure, and statement of assets and liabilities, for the year ending the 31st December, 1914, duly audited by the Deputy Auditor-General; and the Public Trustee's statements of the Carter Bequest, the Hutton Memorial Fund, and the Hector Memorial Fund, for the year ending the 31st December, 1914, duly audited by the Deputy Auditor-General. All of these statements were, on the motion of Mr. Hill, seconded by Mr. Turnbull, adopted.

Statement of Receipts and Expenditure for the Year ending 31st December, 1914.

Receipts.	£	s.	d.
Balance at credit in Bank of New Zealand	452	14	1
Government grant ..	500	0	0
Transactions sold locally ..	3	0	7
"Maori Art" sold ..	4	15	6
Bulletins sold	1	15	3
Authors' reprints	0	10	3
Wesley and Son, London: Transactions sold ..	13	6	3
Refund by Customs, account Dixon's bulletin ..	1	2	0
Postages refunded by societies	14	11	6
Hector Memorial Award ..	40	0	0
	£1,031	15	5

Expenditure.	£	s.	d.
Governors' travelling - expenses	45	15	8
Fire - insurance premium, library, £1,500	5	0	0
Secretary's salary	25	0	0
Assistant Secretary's salary	25	0	0
Custodian's salary, 1913–14	10	0	0
Compiling catalogue scientific literature	10	0	0
Bank charge	0	10	0
Covers for posting Transactions	7	12	6
Government Printer, account vol. 45 and pamphlets ..	334	2	6
Hon. Editor, petty cash ..	3	0	0
Postage on Transactions ..	19	14	6
Whitcombe and Tombs, stationery	1	2	0
Secretary, petty cash ..	10	0	0
Hector Award to Professor Easterfield	40	0	0
	536	17	2
Balance in Bank of New Zealand	494	18	3
	£1,031	15	5

Balance at credit of the Institute in the Bank of New Zealand, Wellington £494 18 3

Statement of Liabilities and Assets at 31st December, 1914.

		Liabilities. £	s.	d.	Assets. £	s.	d.
Dec. 31.	To Balance due Government Printer	416	7	3	..		
	Cost compiling catalogue scientific literature ..	10	0	0	..		
	By Transactions, &c., sold, not paid for	..			37	17	8
	Authors' reprints not yet paid for	..			5	5	5
	Balance in Bank of New Zealand	..			494	18	3
		426	7	3	538	1	4
	Credit balance ..	111	14	1	..		
		£538	1	4	£538	1	4
	By Balance	..			£111	14	1

In addition to the above assets, the Institute [illegible] a large stock of Transactions for sale, and possesses a very valuable library.

CARTER BEQUEST.—Statement of Accounts, 31st December, 1913, to 31st December, 1914.

	Dr.			Cr.		
		s.	d.	£	s.	d.
By Balance as at 31st December, 1913 ..				3,411	0	8
Debentures—						
Prior lien debenture stock fractional scrip ..	..			15	0	11
A and B stock fractional scrip	..			2	1	6
Interest, N.Z. Loan and Mercantile Agency ..	..			0	10	6
Dividends, N.Z. Loan and Mercantile Agency ..	..			0	7	9
Public Trust Office, interest	..			153	13	9
To Public Trust Office, commission and postages ..	0	10	0	..		
Balance	3,582	5	1	..		
	£3,582	15	1	£3,582	15	1
By Balance				£3,582	5	1

HUTTON MEMORIAL RESEARCH FUND.—Statement of Accounts, 31st December, 1913, to 31st December, 1914.

	Dr.			Cr.		
	£	s.	d.	£	s.	d.
By Balance as at 31st December, 1913				721	5	5
Public Trust Office, interest .				31	10	4
To Beneficiary's Account, New Zealand Institute—						
Grant to J. Hall ..	20	0	0	..		
Grant to Dr. Hilgendorf	10	0	0	..		
Balance	722	15	9	..		
	£752	15	9	£752	15	9
By Balance				£722	15	9

HECTOR MEMORIAL FUND.—Statement of Accounts, 31st December, 1913, to 31st December, 1914.

	Dr.			Cr.		
	£	s.	d.	£	s.	d.
By Balance as at 31st December, 1913				1,077	7	3
Public Trust Office, interest				47	1	3
To Beneficiary's Account, New Zealand Institute: Award to Professor Easterfield	40	0	0			
Balance	1,084	8	6			
	£1,124	8	6	£1,124	8	6
By Balance				£1,084	8	6

Cost of Transactions.—On the motion of Professor Marshall, seconded by Mr. Speight, it was resolved, That the Hon. Treasurer be asked to make a statement of the cost of the volume each year of the New Zealand Institute Transactions and Proceedings, and of other publications issued by the Institute, for the last ten years; and that a statement of the cost of each volume be issued annually.*

* In accordance with this resolution the following return has been supplied by the Hon. Treasurer:—

The cost of printing the last ten volumes of Transactions of the New Zealand Institute is as follows: Vol. 37 (1904), £276 9s. 6d.; Vol. 38 (1905), £280 7s. 9d.; Vol. 39 (1906), £359 18s. 6d.; Vol. 40 (1907), £388 13s.; Vol. 41 (1908), £461 14s 9d.; Vol. 42 (1909), £570 15s. 6d.; Vol. 43 (1910), £412 10s.; Vol. 44 (1911), £427; Vol. 45 (1912), £374 10s.; Vol. 46 (1913), £323 5s. These amounts included the cost of printing the Proceedings separate and with the volumes.

Hutton Fund Grants for Research.—Reports from Dr. Hilgendorf and Mr. T. Hall on the progress of the work for which grants were made to them last year were received.

Grants for the Present Year.—Several applications for grants from the fund, which had been received and referred to a special Committee, were dealt with by that Committee, who recommended that £15 be granted to Dr. C. A. Cotton as a contribution towards his travelling-expenses in an investigation of the physiographic features of the New Zealand coast, and £15 to Mr. W. R. B. Oliver, to defray expenses of travelling and apparatus for a visit to Lord Howe Island, undertaken in November, 1913.

Hector Award Committee.—The report of the Committee of Award was received, recommending the award for 1915 be made to Professor P. Marshall for his work on the geology of New Zealand. The recommendation of the Committee was unanimously adopted, and the President congratulated Dr. Marshall, who suitably replied.

Publication Committee's Report.—The report of the Publication Committee was received and approved, as follows:—

REPORT OF THE PUBLICATION COMMITTEE.

The Publication Committee begs to submit the following report for the year:—

Fifty-five papers were forwarded for the consideration of the Committee, and, of these, fifty were published in the Transactions, vol. 46, which was issued on the 15th June. It contains 436 pages, 12 plates, and a large number of illustrations in the text.

Bulletin No. 3, Part II, "Studies in the Bryology of New Zealand," by H. N. Dixon, M.A., F.L.S., was issued on the 7th September, and contains 43 pages and 2 plates, the blocks for which were prepared in England by West, Newman, and Co., under the superintendence of the author.

The two papers on New Zealand *Coleoptera* by Major Broun mentioned in last year's report were issued as Parts II and III of Bulletin No. 1 on the 29th May; a further paper on the same subject is now in the press, and will shortly be issued as Part IV of Bulletin No. 1.

Sixty-eight papers have been sent in for vol. 47 of the Transactions, and a considerable number of these are already in the hands of the printer.

At the last annual meeting of the Board of Governors two questions were referred to the Publication Committee—viz., the possibility of issuing the Transactions more frequently than once a year, and the advisability of recommencing the separate issue of the Proceedings—which will be dealt with in separate reports.

For the Committee.

CHAS. CHILTON, Hon. Editor.

Publication of Proceedings.—The Publication Committee begs to report that it has considered the question of reissuing the Proceedings separately, and considers the Institute would not be justified in incurring the additional expense necessary during the present crisis.

Publication of Transactions.—The Committee appointed to consider the question of publishing the Transactions oftener than once a year begs to report that, as the change would probably lead to some additional expense, it recommends that no action be taken this year.

Major Broun's Work on Coleoptera.—The President read a letter from Major Broun, and asked for instructions regarding a further paper. On the motion of Professor Marshall, seconded by Mr. Petrie, it was resolved, That the question of publishing Major Broun's paper on *Coleoptera* be referred to the Publication Committee to make all necessary inquiries and to report to the Standing Committee before action is taken.

Librarian's Report.—The Hon. Librarian's report was read and adopted, as follows :—

HON. LIBRARIAN'S REPORT.

Owing to the congestion in the room of the Museum used jointly for the library of the New Zealand Institute and of the Wellington Philosophical Society, it has been found necessary to remove and store a large number of old books. This operation has been delayed owing to the use of this room during the greater part of the year for other Museum purposes, and is not yet completed, but it has enabled the majority of the current journals to be assembled, tied up in volumes, and placed on the shelves. At the same time I have introduced a partial geographical classification in the arrangement of the journals, making it easier to trace and find them. I propose also to supply an additional number of light ladders to enable more ready access to the higher shelves. When these arrangements are completed the library will be much more easy to work and use.

It must not be forgotten, however, that the placing of the volumes in the shelves without binding is not only an unsatisfactory procedure, but is one that makes the ultimate putting of the library in order a more difficult and costly matter with every year that passes. As proposals regarding the library will come before the Board of Governors in the form of a report from the Standing Committee, it is not necessary to make any remedial suggestions at this juncture.

Library Committee.—It was proposed by Dr. Allan Thomson, seconded by Professor Farr, That a Library Committee of three, including the Hon. Librarian, be appointed.—Carried.

Dominion Scientific, Art, and Historical Library.—The following report was received from the sub-committee (appointed by the Standing Committee) to draw up conditions under which the library of the Board of Governors should be offered to the proposed Dominion Scientific, Art, and Historical Library :—

CONDITIONS UNDER WHICH IT IS RECOMMENDED THAT THE LIBRARY OF THE NEW ZEALAND INSTITUTE BE HANDED OVER TO THE BOARD OF SCIENCE AND ART.

The Board of Governors hereby offer to hand over their library to the custody of the Board of Science and Art, to form an integral part of the Dominion Scientific, Art, and Historical Library as constituted under the Science and Art Act of 1913, on the following conditions :—

(1.) That the transfer of books do not take place until a fireproof building of modern design has been erected for the housing of the books and a competent librarian has been appointed to give his whole time to the management of the library.

(2.) That the library be a reference library, the books or periodicals of which do not circulate for home use ; but that members of the New Zealand Institute shall have access to the library at reasonable hours, and that any member of the New Zealand Institute who is engaged in research may, upon recommendation of two Governors of the Institute, receive from the Librarian a special permit to take out books and periodicals for home use.

(3.) That in the event of the Science and Art Board being disbanded, or its constitution being reorganized under a new Act of Parliament, the Institute have the right to withdraw its collection of books in whole or in part from the Dominion Science and Art Library.

(4.) That the Board of Science and Art shall make provision in the new Dominion Museum and Library building for a board-room for the use of the Board of Governors of the Institute.

Professor Easterfield presented the report, which was considered, and on the motion of Mr. Ewen, seconded by Professor Kirk, it was resolved, That the Board of Governors hereby offer to hand over their library to the custody of the Board of Science and Art, to form an integral part of the Dominion Scientific, Art, and Historical Library as constituted under the Science and Art Act of 1913, on conditions to be agreed to by the Institute and the Board of Science and Art, and that the transfer of the

library do not take place until a fireproof building of modern design has been erected for the housing of the books and a competent librarian has been appointed to give his whole time to the management of the library.

A motion by Professor Farr, seconded by Mr. Petrie, That the question of handing over the Institute library to the Science and Art Board be referred to the various local Institute Councils for consideration, and that these Councils be asked to report before June to the Standing Committe, was lost.

Professor Easterfield moved, and Mr. G. M. Thomson seconded, and it was carried, That clauses (2), (3), and (4) of the recommendations of the sub-committee be the basis upon which negotiations with the Science and Art Board be based, and that these clauses be referred back to the Standing Committee, with power to act.

On the motion of Mr. Petrie, seconded by Professor Marshall, it was resolved, That the words "That the books handed over by the Institute" be substituted for the first three words of clause (2), and that "these books" be substituted for "the library" in line 3.

Finances of the Institute.—On the motion of Mr. G. M. Thomson, seconded by Mr. Hill, it was resolved, That this Institute bring under the notice of the Government the fact that its work is constantly hampered and limited by lack of adequate funds, and urge that as early as possible the statutory grant of £500 be increased to £750.

On the motion of Mr. H. Hill, seconded by Dr. L. Cockayne, it was resolved, That the question of levy as recommended by the Treasurer be deferred for consideration until the next annual meeting of the Institute.

Correspondence.—Correspondence was received as follows:—

Tongariro National Park.—A letter dated the 12th January, 1915, from the General Manager, Tourist and Health Resorts, stating that action was being taken to enlarge the boundary of the park, was received. It was resolved, on the motion of Professor Kirk, That the letter be received, and the matter be kept steadily in view by the Standing Committee.

Grasses of New Zealand.—A letter dated the 12th January, 1915, was received from the Secretary of the Agricultural Department, to the effect that the proposed work by Mr. Petrie would have to stand over until times were normal again.

Plumage Bill.—A letter dated the 1st December, 1914, from the Royal Zoological and Acclimatization Society of Victoria was received, and, on the motion of Professor Kirk, seconded by Mr. G. M. Thomson, it was resolved, That the Institute again ask the Government to bring in a Bill on the lines of the British Plumage Act.

Replies from Dr. R. McNab and Professor Engler in response to congratulatory motions passed at the last annual meeting were received.

Cape Kidnappers Gannets Reserve.—A letter dated the 21st December, 1914, was received from the Under-Secretary of Internal Affairs, advising that arrangements are now being made with the owners of the land to convey the area to the Crown to be set apart as a reserve. It was resolved that the thanks of the Institute be tendered to Mr. Gordon for his gift and to the Government for its action.

Dr. Mortensen's Report on New Zealand Echinodermata.—The President read a letter from Dr. Mortensen concerning the publication of papers by him on the *Echinodermata* of New Zealand, and it was resolved, on the motion of Professor Easterfield, seconded by Mr. Petrie, That the Publication Committee be authorized to make arrangements for the publication of the work.

Cost of Illustrations in Transactions.—A report from the Secretary, with quotations from London firms showing the cost of producing coloured illustrations, was referred to the Publication Committee for consideration and report.

Fishes of New Zealand.—On the motion of Mr. G. M. Thomson, seconded by Professor P. Marshall, it was resolved, That, in consideration of the vast importance of the fishing industry, this Institute again brings before the Government the desirability of having a catalogue of the fishes of New Zealand prepared at as early a date as possible.

Thermal Regions of New Zealand. — On the motion of Mr. Speight, seconded by Professor Marshall, it was resolved, That the Government be urged to undertake the preparation of a complete scientific report on the thermal regions of the North Island, and that the matter of choosing a time for approaching the Government be left in the hands of the Standing Committee, with power to act.

Honorary Member.—Dr. W. Bateson, F.R.S., was elected an honorary member of the Institute.

Election of Officers.—The following officers for the year were elected: *President*—Mr. D. Petrie; *Hon. Treasurer*—Mr. C. A. Ewen; *Hon. Editor*—Professor C. Chilton; *Library Committee*—Dr. Cockayne, Dr. Cotton, and the Hon. Librarian; *Hon. Librarian*—Dr. J. Allan Thomson; *Publication Committee*—Professors Benham, Chilton, Farr, and Messrs. Speight and G. M. Thomson; *Secretary*—Mr. B. C. Aston; *Hector Award Committee for 1915*—Professor Pollock, (Sydney), Professor Carslaw (Sydney), Professor W. E. Cooke (Sydney), and Rev. Father Piggott (Sydney).

Salaries.—It was resolved that the Secretary's salary be the same as last year.

Travelling-expenses. — It was resolved that the hotel and travelling expenses of the Governors should be paid.

Date and Place of next Annual Meeting.—It was resolved that the meeting be held on the last Friday in January, 1916, in Wellington.

Votes of Thanks to the Hon. Editor and President (Professor Chilton), to the Hon. Treasurer (Mr. C. A. Ewen), to the Hon. Acting-Treasurer (Professor von Zedlitz), and to the Hon. Librarian and Hon. Acting-Secretary (Dr. Allan Thomson), were passed.

Confirmed, 30th January, 1915.

D. PETRIE, President.

PRESIDENTIAL ADDRESS.

The following is the presidential address delivered at the annual meeting of the Board of Governors of the New Zealand Institute, at Wellington, on the 29th January, 1915, by Charles Chilton, M.A., D.Sc., LL.D., F.L.S., Professor of Biology, Canterbury College :—

Gentlemen of the Board of Governors of the New Zealand Institute,— Before we commence the business of our meeting it is our sad duty to record the loss of one of our number—Mr. James Stewart, C.E., of Auckland. Mr. Stewart had been a member of this Board from its reconstitution in 1903, and was with us at our last annual meeting, and, though well advanced in years, he appeared then in his usual health, and followed the business with his customary care and keenness. Very shortly after our meeting, however, he passed suddenly away. In the name of the Institute I sent an appropriate message to his relatives, and a brief obituary notice was inserted in the last volume of the Transactions. Our aged members must in the course of nature be taken from us one by one, and, while we mourn their loss and rejoice in the results of their labours, we should be reminded thereby of the greater responsibility that rests on those of us that are left, and be stimulated to renewed effort while we still have the opportunity.

Early last year we were able to join our scientific brethren of Australia in rejoicing at the safe return from the Antarctic Continent of Dr. Mawson—now Sir Douglas Mawson—and his companions, and later on we had the pleasure of hearing from his own lips an account of the splendid results achieved notwithstanding the extraordinary difficulties and dangers that were met with, and of getting a vivid and accurate idea of life in the Antarctic from the exceptionally beautiful and varied series of pictures that he was able to display. Judging from what I have seen of some of his collections, I feel confident that the biological results of the Australasian Antarctic Expedition will equal, if they do not surpass, those of any other Antarctic expedition in their interest and completeness. I trust that Sir Douglas Mawson's endeavour to obtain sufficient funds for the adequate publication of the results of his researches will soon be rewarded with success.

But from Australia there comes also cause for sorrowful condolence. Some two or three months ago the Commonwealth Federal Investigation Steamer "Endeavour," which has done so much good work in bathymetrical and biological observations round the coasts of Australia, was sent on a mission to Macquarie Island, and has not since been heard of, and there seems little doubt that she has been lost with her crew and scientific staff—another sacrifice to the claims of science and the destructive seas of sub-antarctic regions.

Sir Ernest Shackleton's expedition has gone to the far South in its adventurous effort to cross the Antarctic Continent from the shores of the Weddell Sea to those of the Ross Sea, and later on we shall be anxiously looking for news of the welfare of the leader and of those who are with him.

It gives me great pleasure to announce that the long-expected illustrations to Mr. Cheeseman's "Manual of the New Zealand Flora" have been recently published in two handsome and valuable quarto volumes. The work has been in preparation for several years; it has cost much both in human exertion and in money, and the result is highly creditable both to the author and to the Dominion. We can heartily congratulate Mr. Cheeseman on the publication of another noteworthy contribution to the botany of New Zealand.

I regret to say that the similar series of plates to illustrate Mr. Suter's "Manual of the New Zealand *Mollusca*," to which I referred last year, has not yet been issued, though the work connected with their preparation has been completed, and it is hoped that they will very soon be printed.

Last year we took pleasure in conveying to a distinguished foreign botanist—Professor Engler, of Berlin—on the occasion of his seventieth birthday, our congratulations on his long years of service to botanical science, and an appropriate reply from him will be found among the correspondence to be presented to you later on.

To-day we are engaged in a life-and-death struggle with the German nation; international courtesies and schemes of co-operation for scientific work are suspended, and the resources and inventions of science are being used to carry death and destruction to thousands and tens of thousands of the finest individuals of the manhood of the nations, while as incidents in the struggle—incidents that are scarcely apologized for as regrettable—ancient and famous universities and libraries are destroyed, beautiful and historic cathedrals are laid in ruins, and town-halls and other public buildings, the pride and glory of the citizens, are battered to pieces. It is a ghastly and pitiful

spectacle, and it is a poor consolation to the evolutionary biologist to be able to recognize the war as only a part of that great and grim struggle for existence, universal among organisms, by which nature evolves to higher things. We can only hope that as the final result nations will arise with loftier ideals, and a higher and nobler appreciation of the claims of humanity, righteousness, and justice. In the meantime, we must all sympathize with one of our number, Dr. Cockayne, the result of whose years of labour spent in the preparation of a work on the vegetation of New Zealand for the German series " Die Vegetation der Erde " seems likely to be lost beyond recovery.

Of the business arising out of our last meeting that will come again before you, perhaps the most important is that dealing with the proposed contribution by the district Institutes towards the funds of the New Zealand Institute. I am glad to say that practically all the Institutes have agreed to the principle of the contribution, some of them, naturally enough, restricting their acceptance of it to one year only. Not only will the levy be a valuable means of assisting the scanty funds of the central body, but it will, I feel sure, strengthen the connection between the Institutes and this Board, and make the district Institutes feel that they are really, as they are legally, an integral part of the New Zealand Institute. In case there may be any misapprehension on the point, let me say at once that in my opinion the payment of this contribution will not in any way lessen the necessity or the justice of appealing to the Government at the proper time to increase the amount of the statutory grant; it will show, rather, that we are prepared to contribute from our funds as readily as we have always contributed by our labours towards the requirements of the Institute, and thus demonstrate that we are deserving of further assistance. Even for the work that we now do, our funds are far from adequate, and the Institute could easily widen its sphere of work and of usefulness if it were assured of adequate funds; for example, our publications, creditable through they are, appear small and unimportant in comparison with those of many other similar societies.

Last year I endeavoured to draw attention to the condition of our library, and of the collections housed in the Dominion Museum. I regret to say that things are pretty much in the same unsatisfactory condition still. The Museum is still standing in the same place, and, though one or two minor alterations have been effected to make it more habitable, there has been no real improvement, and the valued collections are no safer from destruction than they were when I addressed you on the subject last year. The Science and Art Board appointed by the Act of 1913 was constituted in May, 1914, by the appointment of its members, and it is gratifying to know that in addition to the President of the Institute, who is a member *ex officio*, two other members of this Board have been appointed to the Science and Art Board. As yet, however, the Board has not been called together, and no steps have been taken to carry out the work for which it was established.

Under the Science and Art Act of 1913 provision is made for the formation of a Dominion Library, and proposals were made at your last annual meeting by which, under proper conditions and safeguards, the Institute might be willing to allow its library to form a part of this Dominion Library. Further and more detailed suggestions in the same direction will be laid before you at this meeting, and will require your earnest and careful consideration.

The genuine worker in any department of knowledge—in science, history, economics, or literature—requires books, not because of any pride he may take in their possession but for the use he can make of them. Provided he can have ready access to them, and make full use of the information contained in them, it is a matter of indifference to him whether they are owned by himself or by some one else. Similarly, as the Institute is never likely to want to sell its library, it does not matter whether the books legally belong to the Institute or to the Dominion Library; all that is necessary is that the working members shall be allowed to use the works with no restrictions other than those that are absolutely necessary for the safety of the volumes and for securing similar privileges to other members. It is important that we should definitely make up our minds as to the kind of library we want. It was pointed out clearly by one of our members at a meeting of the Standing Committee that what we require is a library that will be used for the purposes of research—a library, therefore, partaking largely of the character of what is generally known as a reference library, and as unlike the ordinary circulating library as possible; and yet if the library is to be of any real use there must be adequate provision for sending its volumes freely to those who wish to make use of them.

Much has been said about the erection of a suitable building in which the library could be safely housed. The difficulty of providing the funds that were deemed to be necessary for this purpose is the chief cause of our want of progress in this matter in the past, and during the present European crisis, while all our available resources must

necessarily be used in the first place for securing the maintenance and ultimate victory of the Empire in its great struggle, it is not to be expected that funds can be provided for a costly library building.

But is such a building necessary at all? Let us consider what we mean by a library—a research library. Such a library consists of books or papers, printed or written, containing information of value. The building is no essential part of the library, and has no value or interest to the investigator apart from the fact that it is the place where he can find the books containing the information he wants. Naturally, the books must be stored somewhere; but it is a matter of indifference whether they are all in one building or scattered in many buildings, whether all in one centre or widely separated, provided only they are readily accessible to those who require them.

In biology we are familiar with what we call vestigial organs—remnants or survivals of organs or structures that once were useful to their possessors, but have long since ceased to have any useful function. By the struggle for existence among organisms these survivals are finally got rid of altogether, or so greatly reduced that their presence causes no inconvenience; but among the institutions and customs of civilized societies we have many survivals that, unfortunately, are much more difficult to get rid of, and form serious hindrances to progress. The idea that a building is an essential part of a library is a survival from previous centuries, when books were scarce and consequently of great value, and were housed in some building near the centre of the village or the community, and when the rapid means of transport and of intercommunication from one end of a country to the other that we enjoy in the twentieth century were not dreamed of.

I will endeavour to apply this line of argument to the question of our own Institute library in greater detail presently, but first let me remind you of another commonplace biological principle—every organism is more or less perfectly adapted to its environment, and if the environment changes, and the organism is not sufficiently plastic to change with it, then the organism necessarily falls behind in the struggle, and is doomed to ultimate destruction.

Now our social, political, and scientific institutions or societies are organisms—they are composed of living members or units, just as an animal or plant is composed of living cells, but in many cases the struggle to which they are subject is not keen enough to bring about perfect adaptation to changed circumstances. Our Institute, for example, has grown up largely on the model of scientific societies in England, in the countries of Europe, or in the States of Australia, where there is one dominant centre of population and of activity in which the great majority of the members reside, or to which they are naturally and readily attracted. Consequently, these societies can with advantage have a central and permanent home, where the office and library can naturally be placed. But the condition of things is altogether different in New Zealand, where we have no dominating centre, but at least four centres of activity of approximately equal importance, and our Institute will always fall short of complete success so long as it fails to adapt itself to the peculiarities of its New Zealand environment.

You can easily follow out the parallel for yourselves, but what I want to urge upon you is that in our policy for the future control of the Institute we should endeavour to get rid of the idea that it must necessarily be permanently associated with any single geographical locality, and must arrange the machinery for its management so that it can adapt itself to varying conditions as they arise, our great object being to see that the influence of the Institute is exerted and its advantages enjoyed wherever they will be most effective in promoting the objects for which it was established.

All the meetings of this Board, with two exceptions, have been held in Wellington, and all the members of the Board nominated by the Government since the reconstitution of the Board in 1903 have been residents in Wellington. There is no justification for either of these courses unless they have been desirable in the best interests of the Institute. Our Institute is composed of the members of the district Institutes incorporated with it, and these are scattered over the whole of New Zealand; and where the members are, there should the Institute be. To keep in touch with our members, to help them in their work, and to learn what they can teach us, we should endeavour to meet in rotation in the different centres where the district Institutes have their headquarters. These Institutes differ in character, constitution, and methods of work; and it is not desirable that they should be otherwise, or that we should endeavour to impose any uniformity upon them—each will do its work best by adapting itself to the particular needs of its special environment. But it is essential that this Board, which has the general control of them all, should be thoroughly acquainted with the special characters of the Institutes, and that the members of one Institute should have some opportunity of meeting those of other Institutes, and of receiving the stimulation and encouragement that arises therefrom. There may be practical difficulties in the way, but I am endeavouring to

put before you the ideal that we should aim at; and if we fully realize that, and strive to reach it, some way of overcoming the difficulties will readily be found. If we are to become acquainted with the Institute as a whole, we must endeavour to meet periodically at least in the four chief cities—Auckland, Wellington, Christchurch, and Dunedin. A suggestion was made some years ago that we might meet at the same place and about the same time as the Senate of the New Zealand University. On the Senate are usually some who are also members of this Board; at present there are three, and there might be more if it were possible to attend the meetings of both bodies without inconvenience. Those members, being present at the Senate meeting, could attend the Institute meeting without additional travelling or expense, and the opportunities that would be afforded for the meeting of the learned members of two bodies having so many objects in common would exert a widening and invigorating influence on both.

But we must do much more than this if we are to reach our individual members effectively. In the New Zealand Institute Act it is provided that "The Board of Governors may from time to time, as it sees fit, make arrangements for the holding of general meetings of members of the Institute, at times and places to be arranged, for the reading of scientific papers, the delivery of lectures, and for the general promotion of science in New Zealand by any means that may appear desirable." That clause was, I believe, inserted on the suggestion of the late Captain Hutton, who hoped that the Institute would one day be able to hold meetings something like those of the British and Australasian Associations for the Advancement of Science. We have made no effort to hold such general meetings, and I am afraid we are in danger of looking upon the annual meeting of the Board of Governors as being held almost entirely for the purpose of making arrangements for the publication of the Transactions, the presentation of an annual report and balance-sheet, the payment of accounts, and of other routine business; and the result is that the existence of the New Zealand Institute is unknown to the great majority of the people of New Zealand. Extension of our work would be beneficial to the community generally and to ourselves, for we are doing valuable and useful work, and if we can only make this evident to the electors we shall have no difficulty in procuring funds for further extension of the work. If the Board of Governors were to hold its annual meetings at various centres in rotation, we could easily arrange for general meetings of the members at the same time, to which the public could be freely invited. The details of the necessary arrangements could be left to the district Institute at the place where the meetings were held, and the stimulus of the work of preparation and of the healthy competition between the different Institutes in the effort to hold the most successful meetings possible would, I feel sure, speedily cause greatly increased growth of the whole Institute. At present there are many persons in the general community genuinely interested in scientific matters who are ignorant of the work of the Institute, and who receive no assistance from it.

We can now return to the consideration of our library. The present position is that, although we have a library of considerable size and value, it is stored in such a way that it is practically inaccessible and of no use to the members. We have often been told that research in New Zealand is greatly hindered by the want of properly equipped libraries. There is, of course, considerable truth in this statement; but, on the other hand, it is equally true that we do not make anything like the use we should of the books that are in New Zealand, and this is especially true in the case of the Institute library.

Our library consists mainly of the scientific journals and periodicals that have been received during the last forty-five years in exchange for our Transactions. If these were available for use, we would have a library of fair completeness and of extreme value, especially to the workers in zoology, botany, or geology, the sciences in which research is most urgently needed and is most easily carried out.

Now, as you know, these books are not available. Some of them are in the library-room of the Museum; others are stored away somewhere else in the Museum, either on shelves or in cases; but it is impossible to tell what books are in the library, or in many instances to find any particular volume that is required. What have we done to try to improve matters? For the last twelve years we have appointed Library Committees and Librarians, and we have received reports, but we have not succeeded in making any real improvement, and the condition of affairs appears to be growing worse instead of better. What can be done? The first thing that is necessary is to overhaul the library, and find out what books we have. One member of this Board now resident in Wellington, Dr. Cockayne, has offered to devote part of his valuable time to assisting in this work. At first sight, and judging from our want of success in the past, it would appear to be a hopeless task, but I have little doubt that if he were assisted by two or three others as enthusiastic as himself, and were allowed the use of a few clerks or typists, the great part of what is necessary could be accomplished in a fortnight, and at a cost small in itself and trivial in comparison with the value of the work done.

What are we going to do with them when we have found out what books we possess? We have no room to store them in the Museum in the way they should be stored—accessible for use—and we are not likely to have a building in Wellington suitable for the purpose placed at our disposal for a long time to come. Moreover, as I have tried to show you, it is neither necessary nor desirable that we should continue to try to store them all in any one place. The books belong to the members of the Institute, and are required by the working members scattered all over New Zealand; and where these members are, there should the books be. Let us decentralize our library: send the geological journals and books, for example, to Dunedin, or to any other place where they are likely to be most used; the botanical to Auckland; and so on. In the four large centres it would probably be easy to find some library belonging either to the district Institute or to some other institution in which the books could be stored, and to get the librarian or some other person interested in the particular subject to take charge of them. In this way we could at once get rid of the difficulties about the library building and the want of funds to employ a librarian with sufficient time to attend to the duties of the position. But how are we going to manage even if we separate our library this way? You will perhaps say that we must, first of all, have a complete catalogue, so that any member may know what work is in the library, and where it is to be found. But this is quite unnecessary, if by a catalogue you mean an ordinary printed catalogue giving a list of the whole of the books. Such a catalogue may be desirable in a circulating library, the subscribers of which do not know what book they wish to consult, and use the catalogue to find some book suitable to their taste. But for a research library such a catalogue is unnecessary, and is only a useless "survival." I well remember years ago going into the library of the University of Edinburgh and being shown the catalogue which was being prepared. It then consisted of about thirty large manuscript volumes; it was far from completion, and it had been found impossible to go to the expense of getting it printed. It would be quite unnecessary for the person engaged in special research if it could be printed, because during the progress of his research he always finds out the particular works that he wishes to consult, and all he wants is some method of ascertaining if they are in the library or not. If I want to find out whether a particular work on *Crustacea* is to be found in the library, it is only a hindrance to offer me a large printed volume containing a complete list of works on all subjects, and to waste my time in making me turn over many pages containing lists of works on geology, botany, and other subjects, until I come to the special page devoted to the *Crustacea.*

If you agree with this you will probably say that what we want is a card catalogue, and that if our library is decentralized there should be a complete card catalogue of the whole of it in each of the four large cities. But even this, though it might be useful in some cases, is by no means necessary. The person who is in charge of any portion of the library must, of course, be able to find out what books he has under his care, and to get them when wanted, and for this he may make a card catalogue or adopt any other suitable method he pleases. But all that is necessary for the worker is that he should know where the section of the library dealing with the subject in which he is working is kept, so that when he finds he wants a particular volume or paper he can send a post-card asking if the volume is there and, if so, if he could have it, and receive an answer or the volume by return of post.

It might be thought that all this will require elaborate organization, and will lead to a large amount of clerical work; but if you consider the small number of men in New Zealand who are engaged in research in each particular science or branch of science, and if you remember that the library may be subdivided to any extent that may be found desirable, you will see that the work required will also be so divided that it could be accomplished without difficulty, and without appreciably increasing the labours of the persons in charge of the different sections. For instance, if you send the books dealing with geology to the place where the greatest amount of geological work is being done, they will be accessible without trouble to the workers there, and probably there will not be more than a score of applications by workers from other districts in the whole of the year; and it would not be a difficult or arduous task to reply to a score of post-cards in the course of twelve months. As a matter of fact, this method is already in operation to a limited extent, and in a few cases books have been sent from the local Institute libraries to workers in other districts on the few occasions on which they have been asked for.

It will be objected that if we scatter our library in this way we run the danger of losing many of the volumes. Naturally, we should stamp the books and take the usual elementary precautions to ensure the safety of the volumes, and a list of the works at each particular place would be made and a record kept of the books sent on to individual workers. It is, however, possible that, notwithstanding such checks, a

few books, from time to time, might be lost in transit, or by the failure of those to whom they had been sent to return them; but with ordinary checks those losses could be kept to a minimum, and it is far better to use your library even if a book is occasionally lost than not to use it at all. It is not good policy to preserve your books by destroying their use. For all practical purposes the great part of the Institute library has been lost for many years.

I am afraid I have kept you too long, and that, instead of giving you a presidential address dealing in general terms with the work of the Institute, I have brought before you debatable matters and detailed methods which would be better discussed by the executive committee. But in doing so I have been trying to carry out the principle of adaptation to the environment. A presidential address delivered to a large gathering of general members of a society who are not directly concerned in its working can appropriately deal in a wide and general manner with the objects or aspirations of the society, while the details of its management are left to an executive committee, and are therefore not dealt with in the address. But this Board is the executive committee of the Institute, and I have, therefore, endeavoured to place before you some definite suggestions for the more efficient carrying out of our duties, and, as my term of office as President will naturally end at the conclusion of this meeting, I have been anxious to take this opportunity of doing so.

I have to thank you for the patience with which you have listened to me, and for your assistance and courtesy during my term of office as President. I have been connected with the Institute for a long period, and many of my most pleasurable experiences have been associated with its work. In resuming my position as an ordinary member I shall do so with the full intention of performing to the best of my ability the duties appropriate thereto—that is, I shall endeavour to continue to be an active and, I hope, a vigorous and efficient cell in the organism that we call the New Zealand Institute.

AUCKLAND INSTITUTE.

FIRST MEETING: *8th June, 1914.*

Professor H. W. Segar, Vice-President, in the chair.

New Members.—Miss Adlington, J. Barr, J. A. Bartrum, Dr. Marsack, Miss K. Edgerley, Professor J. C. Johnson, T. L. Lancaster, Dr. K. McKenzie, Professor G. Owen, S. H. Pryor, Dr. Carrick Robertson, S. C. Rountree, J. L. Strevens, Professor F. P. Worley.

Lecture.—"The Art of Road-making: Past, Present, and Future," by Mr. F. E. Powell, C.E.

The lecturer traced the development of road-making from the time of the Romans up to the advent of the motor vehicle, when the older methods failed and road-builders were forced to use new types of construction and to experiment with new materials. He then endeavoured to show the probable trend of road-construction in the future, accompanying his remarks with numerous diagrams and lantern-slides.

SECOND MEETING: *6th July, 1914.*

Professor H. W. Segar, Vice-President, in the chair.

Lecture.—"Petroleum and its Occurrence in New Zealand," by Mr. J. L. Strevens, late chief chemist to the Taranaki oil-field.

This was an attempt to explain the principles of oil-finding and its exploitation as followed in other countries, and to show how far such principles are applicable to New Zealand. The lecture was fully illustrated with limelight views.

THIRD MEETING: *17th August, 1914.*

Professor H. W. Segar, Vice-President, in the chair.

New Member.—J. G. H. Mackay.

Lecture.—"The European Crisis: its Historical Aspects," by Mr. J. P. Grossmann, M.A., Lecturer on Economics and History at the Auckland University College.

FOURTH MEETING: *31st August, 1914.*

(British Association Lecture.)

C. J. Parr, C.M.G., President, in the chair.

Lecture.—"Heredity and Eugenics," by Dr. C. B. Davenport.

FIFTH MEETING: *3rd September, 1914.*

(British Association Lecture.)

Professor H. W. Segar, Vice-President, in the chair.

Lecture.—"Heredity and Responsibility," by Professor E. G. Conklin, Princetown University.

SIXTH MEETING: *8th September, 1914.*

(British Association Lecture.)

Professor H. W. Segar, Vice-President, in the chair.

Lecture.—"English Universities and Public Schools," by Dr. H. B. Gray.

SEVENTH MEETING: *9th September, 1914.*

Professor H. W. Segar, Vice-President, in the chair.

New Members.—S. B. Bowyer, W. Todd Smith, Dr. A. G. Talbot.

Lecture.—"Some of the Properties of an Electric Current," by Mr. A. Wyllie, Electrical Engineer to the City of Auckland.

The lecture dealt chiefly with the fundamental phenomena of electro-magnetic induction, and was illustrated by copious experiments.

EIGHTH MEETING: *10th September, 1914.*

(British Association Lecture.)

Professor H. W. Segar, Vice-President, in the chair.

Lecture.—"Explosions," by Professor H. P. Dixon, F.R.S., Professor of Chemistry at the University of Manchester.

NINTH MEETING: *22nd September, 1914.*

(British Association Lecture.)

Professor H. W. Segar, Vice-President, in the chair.

Lecture.—"Anaesthetics in Military Surgery," by Professor A. Waller, F.R.S., London University.

TENTH MEETING: *16th December, 1914.*

C. J. Parr, C.M.G., President, in the chair.

New Members.—J. M. Blair, E. Wake, G. W. Wilton.

Papers.—1. "The Prothallia of Three New Zealand Lycopods," by Miss K. V. Edgerley, M.A.

2. "Descriptions of New Species of Flowering-plants," by T. F. Cheeseman, F.L.S., F.Z.S.

3. "Notes on *Aciphylla*, with Descriptions of New Species," by T. F. Cheeseman, F.L.S., F.Z.S.

4. "The Ferns of Mangonui County," by H. Carse; communicated by T. F. Cheeseman.

5. "Descriptions of New Native Phanerogams," by D. Petrie.

6. "Some Additions to the Flora of the Subantarctic Islands of New Zealand," by D. Petrie.

7. "Records of Borings at Horotiu," by J. R. Hetherington; communicated by D. Petrie.

8. "The *Mollusca* of the Kermadec Islands," by W. R. B. Oliver.

9. "A Comparison of the Land Molluscan Faunas of the Kermadec Group and Norfolk Island," by T. Iredale; communicated by W. R. B. Oliver.

10. "A Commentary on Suter's 'Manual of the New Zealand *Mollusca*,'" by T. Iredale; communicated by W. R. B. Oliver.

11. "New Genera and Species of *Coleoptera*," by Major T. Broun.

ANNUAL MEETING: *22nd February, 1915.*

C. J. Parr, Esq., C.M.G., Mayor of Auckland, President, in the chair.

Annual Report.—The annual report and audited financial statement was read to the meeting, and ordered to be printed and distributed among the members.

ABSTRACT.

Members.—The number of members elected during the year has been twenty-two. The number of names withdrawn from the roll has been thirty-six—four from death, twenty-six from resignation, and six from non-payment of subscription for more than two consecutive years. There has thus been a net loss of fourteen, the number on the roll having been reduced from 370 to 356.

Among the members removed by death the Council regret to mention the names of Archdeacon Walsh, who has been a frequent contributor to the Transactions during the twenty-seven years he has been associated with the society, and who has made many important donations to the collection of Maori antiquities in the Museum; of Mr. W. R. Bloomfield, who was lost in the disastrous wreck of the "Empress of Ireland"; of Mr. W. S. Cochrane, and Mr. E. Bond.

Finance.—The total revenue of the Working Account, excluding the balance in hand at the commencement of the year, has been £1,530 17s. 7d. Last year the amount was £1,862 0s. 2d.; but, as pointed out at the time, that sum included the exceptional item of a Government subsidy for £250, in addition to arrears of interest and rents properly belonging to the previous year. Taking these items into consideration, it will be found that the revenue for the year is not far below that for 1913–14. The amount received under the head of members' subscriptions has fallen from £354 18s. to £322 7s.; and there is an apparent reduction of £37 12s. 6d. in the receipts from the Costley Bequest, and of £16 10s. 8d. in the returns from the Museum Endowment, but both are mainly caused by the payment of arrears in the previous year. On the other hand, a new item of revenue appears in the returns from the Campbell Bequest. The expenditure has been unusually large, amounting to £1,692 19s., as against £1,590 10s. 2d. for the previous year. The increase is due to the numerous purchases made for the Museum, and to the cost of the show-cases required for their exhibition. The balance in hand amounts to the satisfactory sum of £218 9s. 7d.

The position of the invested funds of the society must be regarded as satisfactory. The legacy of £1,000 bequeathed by the late Sir John Campbell, paid over by the Campbell Trustees during the previous year, has been suitably invested, and is now yielding its full revenue of 6 per cent. A further sum of £555 has been derived from the sale by the Government of certain Museum endowments, and has also been invested. From these two sources the capital funds of the Institute have been raised to the sum of £18,181, thus securing an increased revenue in the future of nearly £100 per annum.

Visit of the British Association.—In last year's report it was stated that arrangements had been made by the New Zealand Government to invite a number of the leading members of the British Association to visit New Zealand after the close of the Australian meeting, with the object of holding a short supplementary meeting in New Zealand; but the unforeseen outbreak of war, and the military preparations that at once became necessary, compelled the Government to cancel the greater part of these arrangements,

and, in particular, to abandon the idea of an official meeting of the Association in the Dominion. After the break-up of the Australian meeting, however, a considerable number of members of the Association were able to visit New Zealand, and no small number of lectures or addresses were delivered in the various centres. Six of these were given in Auckland under the auspices of the Institute, and were fully appreciated by the citizens, securing in each case a large and representative audience.

Meetings.—Including the British Association lectures just alluded to, eleven meetings have been held during the year, at which twenty-one lectures and papers were given by members and others.

Museum.—The attendance of visitors has been good, although not quite equal to the standard of the two previous years.

Much progress has been made in the Museum during the year. The additions received by purchase or donation have been numerous and important, while a large amount of material has been derived from collecting-trips made to various portions of the coast. Perhaps the most attractive addition to the zoological department is a special group illustrating the life-history of the spotted shag (*Phalacrocorax punctatus*). It contains numerous specimens of adult males and females in full breeding plumage, together with young birds in various stages of growth, nests, and eggs, and is an exact representation of a portion of Shag Rock, in the Firth of the Thames, which is a great breeding colony of the species.

Two other conspicuous additions consist of a fine specimen of the mako shark (*Lamna glauca*), and an equally good example of the singular thresher shark (*Alopecias vulpes*), in which the length of the tail greatly exceeds that of the body.

Another important addition is an exhibit prepared by the Auckland Harbour Board for the recent Exhibition, showing the damage caused to wooden wharves by the *Teredo*, *Limnoria*, and other genera of marine borers. This was very kindly presented to the Museum by the Harbour Board.

Several important donations have been made to the geological department, including a large series of auriferous-lode specimens and minerals presented by the Talisman Gold-mining Company, and an extensive set of named New Zealand fossils presented by the Geological Survey.

The Maori collection has been largely increased during the year. The most important accession is a series of 336 greenstone, bone, and ordinary stone articles collected by Mr. F. R. Smith, with the assistance of Mr. C. Arnold and others, at Murdering Beach and other localities near Dunedin, in the years between 1874 and 1878. After the death of Mr. Smith the collection passed into the hands of his widow, from whom it has now been purchased. The other additions include a superbly carved *whakapapa*, or genealogical tree, originally obtained many years ago by Captain Preece in the Urewera country during the Maori War, and an unusually large and boldly carved *hei-tiki*, formerly in the possession of the well-known chief Honga Hika. Important donations have been received from Mr. John Kenderdine, Mr. G. Graham, and Captain Bollons, of the s.s. "Hinemoa."

Library.—The annual balance-sheet shows that an expenditure of £197 2s. 8d. has been incurred in the library during the year, £105 of which has been derived from the Mackechnie Library Bequest and the remainder from the ordinary revenue of the society. A consignment of about sixty volumes ordered from London was received last June, catalogued, and placed in the library.

Election of Officers for 1915.—*President*—Hon. E. Mitchelson; *Vice-Presidents*—C. J. Parr, C.M.G., Professor H. W. Segar; *Council*—Professor C. W. Egerton, J. Kenderdine, E. V. Miller, Professor G. Owen, T. Peacock, D. Petrie, J. A. Pond, Professor A. P. W. Thomas, J. H. Upton, Professor F. P. Worley, H. E. Vaile; *Trustees*—T. Peacock, J. Reid, J. H. Upton; *Auditor*—S. Gray.

WELLINGTON PHILOSOPHICAL SOCIETY.

FIRST MEETING: *22nd April, 1914.*

Dr. C. Monro Hector, President, in the chair, and about forty members present.

New Members.—Mr. E. G. Jones, B.A., and Mr. J. McDonald.

Exhibits.—Dr. Thomson exhibited and described a number of interesting specimens of Native work received from New Guinea.

Dr. Newman discussed the exhibits, and contrasted them with Maori work.

Dr. Thomson drew attention to the publication of an important work on New Zealand Palaeontology, the first of a new series on the subject.

Presidential Address.—Dr. Hector delivered his presidential address, on the history and functions of the New Zealand Institute, and notes on the Cawthron Observatory scheme, illustrated by lantern-slides.

A hearty vote of thanks was carried to Dr. Hector for his interesting address.

SECOND MEETING: *27th May, 1914.*

Dr. C. Monro Hector, President, in the chair, and about forty members present.

New Members.—Dr. H. E. Gibbs, Mr. L. G. James, Mr. H. M. Miller, Mr. J. E. L. Cull, Mr. W. H. Gavin, Mr. J. W. Jack, Mr. E. H. Wilmot, Mr. T. Humphries, Mr. D. C. Bates, Dr. T. D. M. Stout, and Rev. I. von Gottfried.

Exhibits.—Dr. Thomson exhibited and described a kiwi mat with a white border, and two preserved Maori heads.

Mr. Harold Hamilton, by the invitation of the President, exhibited and described a peculiarly marked specimen of stone from the Macquarie Islands.

Wireless Time Service.—Professor Laby moved, That in the opinion of this society it is desirable—(1) That the Government should institute a wireless time service, such as is now maintained by international arrangement in Europe and America; (2) that licenses should be issued to amateur wireless operators on similar conditions to those upon which the English Government issues such licenses; and (3) that the above resolution be communicated to the Government by the President.

The resolution was seconded by Mr. A. C. Gifford, President of the Astronomical Section, and carried unanimously.

Address.—Professor Laby delivered an interesting address on "Recent Advances in Physics."

Mr. Morgan, Professor Kirk, Mr. Gifford, Dr. Thomson, and the President took part in the discussion.

Paper.—Professor Laby communicated a paper by Mr. Stewart and Mr. Dall on "Earth-movements due to the Earthquake on the 8th February."

Dr. Thomson, Mr. Morgan, Mr. Adams, Mr. Humphries, Mr. Spencer, and the President discussed the paper.

Mr. Adams announced that a new bright comet had been discovered by Zlatinsky.

He gave particulars of its orbit, and a search ephemeris supplied by the Centralstelle, and forwarded from the Melbourne Observatory.

Mr. Gifford described the path of the comet.

Special Meeting: *4th June, 1914.*

Dr. C. Monro Hector, President, in the chair, and an attendance of about 200.

Professor W. M. Davis, of Harvard University, and an honorary member of the New Zealand Institute, delivered a very interesting and instructive address on the "Origin of the Coral Reefs of Fiji."

Professor Davis was listened to with the closest attention, and on the conclusion of his lecture a hearty vote of thanks was accorded him.

Third Meeting: *24th June, 1914.*

Dr. C. Monro Hector, President, in the chair, and about sixty members and friends present.

New Members.—Dr. L. Cockayne, F.R.S.; Miss G. F. Gisbon, M.A.; Mr. H. F. Von Haast, M.A., LL.B.; and Miss Grace Crawford.

Lecture.—Miss B. Pullen-Burry, F.R.A.Inst., F.R.G.S., delivered a lecture on New Britain (German New Guinea), illustrated by a number of lantern-slides.

Fourth Meeting: *22nd July, 1914.*

Dr. C. Monro Hector, President, in the chair, and about forty members and friends present.

New Members.—Mr. W. Gibson, B.E.; Mr. M. Ongley, M.A.; Mr. F. K. Broadgate, B.Sc.

Papers.—1. "Generalization of certain Elementary Propositions of Geometry," by Professor D. K. Picken.

2. "Notes on Personal Equation."

3. "Longitude of New Zealand," by Mr. C. E. Adams.

Exhibits.—Exhibits by Mr. J. McDonald, Acting Director of the Museum, of Japanese articles presented to the Museum; of photographs of moa, *Cygnus*, and *Notornis* bones found recently in a cave near Pahiatua, and of a skull of *Notornis*.

Fifth Meeting: *23rd September, 1914.*

Dr. C. Monro Hector, President, in the chair, and about 160 members and friends present.

Lecture.—Professor Ernest W. Brown, M.A., Sc.D., F.R.S., F.R.A.S., Professor of Mathematics in the Yale University, New Haven, Conn., U.S.A., delivered a lecture on "The Moon," in which he gave an interesting account of his recent work on the motion of the moon, and showed a number of lantern-slides illustrating the result of his work.

Special Meeting: *24th September, 1914.*

Dr. C. Monro Hector, President, in the chair, and about sixty members and friends present.

Lecture.—Professor Ernest W. Brown delivered a lecture on "The Asteroids."

The lecture was illustrated by lantern-slides, and the most recent researches on the motions of the asteroids were presented, and explanations given of periodic orbits.

Annual General Meeting: *28th October, 1914.*

Dr. C. Monro Hector, President, in the chair, and eighteen members present.

New Members.—Mr. C. J. Freeman, Mr. W. Earnshaw, and Mr. H. Hamilton.

Annual Report and Balance-sheet.—The Secretary read the annual report and balance-sheet.

Professor Kirk, commenting on the reply received by the Society from the Postmaster-General as to wireless amateurs, stated that the society heard this reply with regret, and that the reply showed inability to grasp the position; and on his motion it was agreed that the incoming Council should raise the question again when conditions were normal.

The reports of the Astronomical, Technological, and Geological Sections were read and adopted.

The President congratulated all sections on the valuable work done.

Election of Officers for 1915.—*President*—Mr. Thomas King: *Vice-Presidents*—Dr. C. Monro Hector, Professor Kirk: *Council*—Mr. A. C. Gifford (Chairman, Astronomical Section), Mr. R. W. Holmes (Chairman, Technological Section), Mr. J. Allan Thomson (Chairman, Geological Section), *ex officio;* Mr. P. G. Morgan, Mr. G. Hogben, Dr. Cockayne, Mr. B. C. Aston, Mr. E. Parry, Professor Easterfield, Mr. S. H. Jenkinson: *Secretary and Treasurer*—Mr. C. E. Adams: *Auditor*—Mr. E. R. Dymock.

Papers.—1. "Notes on *Notopanax arboreum*," by Miss E. M. Pigott; communicated by Professor Kirk.

Miss Pigott was congratulated on her paper by the President and by Dr. L. Cockayne. Professor Kirk gave a general review of the paper.

2. "Brachipod Genera: The Position of Shells with Magaselliform Loops, and of Shells with Bouchardiform Beak Characters."

3. "Additions to the Knowledge of Recent *Brachiopoda* of New Zealand."

4. "A Geological Map of the Waipawa District," by Dr. Thomson.

5. "The Longitude, Latitude, and Height of the Hector Observatory," by Mr. C. E. Adams.

6. "Plant-habitats Hitherto Unrecorded," by Mr. B. C. Aston.

7. "Notes on the Taupo District," by the Rev. H. J. Fletcher.

8. "On *Ascidioclava parasitica*," by Professor Kirk.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

First Meeting: *6th May, 1914.*

Present: Dr. Evans, President, in the chair, and about fifty members and friends.

Ex-Presidential Address.—"Animal-life in Underground Waters," by Dr. Charles Chilton.

Special Meeting: *25th May, 1914.*

Present: Dr. Evans, President, in the chair, and about 100 members.

Address.—"The Origin of the Coral Reefs of Fiji," by Dr. W. M. Davis, of Harvard University.

Second Meeting: *3rd June, 1914.*

Present: Dr. Evans, President, in the chair, and about twenty-five members.

New Members.—Professor R. J. Scott, Messrs. C. B. Morris, H. Lang, and S. L. Blackburne.

Address.—"Maps," by Mr. W. F. Robinson.

Third Meeting: *1st July, 1914.*

Present: Dr. Evans, President, in the chair, and about fifty members.

New Member.—Mrs. H. T. Ferrar.

Papers.—1. "Some New *Coccidae*," by Mr. Guy Brittin.
2. "The Intermontane Basins of Canterbury," by Mr. R. Speight.
3. "The Influence of Pressure on the Solubility of Tricalcic Phosphate in Carbonic-acid Solutions," by Mr. P. S. Nelson.

Exhibits.—Dr. F. W. Hilgendorf exhibited a specimen of curious growth in wood.
Mr. L. Birks reviewed the recent progress at Lake Coleridge, illustrating this with lantern-slides and exhibits.

Fourth Meeting: *5th August, 1914.*

Present: Dr. Evans, President, in the chair, and about sixty members.

Address.—"Problem Plays of Ancient Athens," by Professor H. Stewart.

SPECIAL MEETING: *9th September, 1914.*

Present: Dr. Evans, President, in the chair, and about 250 members and friends.

Address.—"Heredity and Eugenics," by Professor Davenport.

SPECIAL MEETING: *10th September, 1914.*

Present: Mr. A. D. Dobson, in the chair, and about 200 members and friends

Address.—"Agricultural Education," by Professor Creelman.

SPECIAL MEETING: *11th September, 1914.*

Present: Dr. Charles Chilton, Vice-President, in the chair, and about 200 members and friends.

Address.—"Irrigation and Agricultural Practice in Egypt," by Mr. H. T. Ferrar.

SPECIAL MEETING: *23rd September, 1914.*

Present: Dr. Evans, President, in the chair, and about 400 members and friends.

Address.—"Explosions," by Professor Dixon.

SPECIAL MEETING: *15th October, 1914.*

Present: Dr. Evans, President, in the chair, and about 400 members and friends.

Address.—"The Evolution of Elements," by Sir Ernest Rutherford.

FIFTH MEETING: *4th November, 1914.*

Present: Dr. Evans, President, in the chair, and about thirty members.

Papers.—1. "Revised List of the Norfolk Island Flora," by Mr. R. M. Laing.

2. "Recent Changes in the Position of the Terminal Face of the Franz Josef Glacier," by Mr. R. Speight.

3. "A Fresh-water Crab, and its Distribution in Australia and New Zealand," by Dr. Charles Chilton.

4. "On Orthogonal Circles," by Mr. E. G. Hogg.

5. "New Zealand Bird-song," by Mr. Johannes C. Andersen.

6. "On Tuis singing in Harmony," by Mr. C. H. Tripp.

SPECIAL MEETING: *4th November, 1914.*

Present: Dr. Charles Chilton, Vice-President, in the chair, and about thirty members.

Address.—"The Wild Flowers of New Zealand," by Mr. J. Crosby Smith.

SPECIAL MEETING: *25th November, 1914.*

Present: Dr. Evans, President, in the chair, and a large number of members and friends.

Address.—"The Electrical and Mechanical Characteristics of the Lake Coleridge Transmission-wire," by Mr. E. Parry.

ANNUAL MEETING: *2nd December, 1914.*

Present: Dr. Evans, President, in the chair, and about twenty-five members.

New Members.—C. E. Christensen and W. G. Morrison.

Annual Report.—The annual report and balance-sheet were adopted.

ABSTRACT.

The Council, in endorsing the suggestion, made by the Wellington Philosophical Society, that a memorial to the late Mr. A. Hamilton, Director of the Dominion Museum, should be erected, made a grant of £5 5s. to the fund.

Consideration has been given to a proposal to send a party to the Chatham Islands to investigate the natural science of the islands, and ultimately to publish the results of the investigations, but owing to the war the matter has been held in abeyance for the present.

The Council has taken action to support the endeavours of the Manawatu Philosophical Society to extend the boundaries of the Tongariro National Park to at least those suggested by Dr. L. Cockayne in his report to the Government on the subject.

The Council actively supported the appeal of Sir Douglas Mawson to the New Zealand Government for the sum of £500 to enable him to publish the physical results of the expedition.

Meetings of the Institute.—In addition to the meetings held in connection with the visit of the British Association members, nine meetings of the Institute have been held during the year, at which the following addresses were delivered: "Animal-life in Underground Waters," ex-presidential address by Dr. Charles Chilton; "The Origin of the Coral Reefs of Fiji," by Professor W. M. Davis, Harvard University; "Maps," by Mr. W. F. Robinson; "Problem Plays of Ancient Athens," by Professor H. Stewart; "Wild Flowers of New Zealand," by Mr. J. Crosby Smith; "The Electrical and Mechanical Characteristics of the Lake Coleridge Transmission-wire," by Mr. E. Parry.

In addition to these, twenty-six papers have been read, which may be classified as follow: Botany, 5; chemistry, 3; geology, 3; mathematics, 1; zoology, 12; miscellaneous, 2.

Visit of Members of the British Association.—In consequence of the war, the proposed Christchurch meetings of the New Zealand Science Congress, which were being organized by a special local committee, were abandoned by the central committee, and the Council of this Institute undertook the entertainment of visiting members, and the arrangement of various public meetings, at which a number of the British and American visitors gave addresses as follow: "Heredity and Eugenics," by Dr. C. Davenport; "Agricultural Education," by Professor C. G. Creelman; "Irrigation and Agricultural Practice in Egypt," by Mr. H. T. Ferrar; "Explosions," by Professor H. B. Dixon; "The Evolution of Elements," by Sir Ernest Rutherford.

The Council entertained a number of the visitors at dinner, and in co-operation with the Mayor accorded a civic reception to Sir Ernest Rutherford.

Membership.—During the year seven new members have been elected, and twenty-three have either resigned or have been struck off the roll, so that the number now stands at 164. The Council regrets to record the loss by death of Mr. F. L. Mouldey, who had for a number of years been associated with this Institute.

Riccarton Bush.—The Council expresses its appreciation of the action of the Deans family in handing over this bush to the public, and the recognition of this Institute in relation to the control of the gift, which is of great historical and scientific interest to the community.

Arthur's Pass Tunnel Investigation.—The usual temperature observations have been continued, and specimens of the rocks were received for examination, thus keeping the series complete.

Library.—During the past year the library has been maintained in an efficient condition. A large sum has been expended on binding, and it is expected that all arrears of binding will be made up by the close of the current year.

Many valuable additions have been made to the library by gift or purchase. To Dr. Cockayne, F.R.S., the library is indebted for a number of scientific works, including the "Journal" and "Proceedings and Transactions of the Linnean Society" (30 volumes and parts), "Bibliothèque de l'école des Hautes Études" (15 volumes), "Amoenitates Academicae" (10 volumes), and "Verhandlungen d. K.K. Zool. Bot. Gesellschaft in Wien," 1855–73 (19 volumes).

With a view to providing magazines of a less technical character and more general interest, the Council have decided to subscribe to "Knowledge," "Science Progress," and "Bed-rock." The back numbers of the two latter publications since their inception have been presented to the library by Mr. R. Speight and Dr. Chilton respectively.

Balance-sheet.—The Institute commenced the financial year with a credit balance in the Bank of New Zealand of £69 2s. 9d.; and the receipts for the year amount to £160 11s. 4d.; the expenditure to £207 2s. 8d., of which £112 11s 6d. has been spent in connection with the library, principally on periodicals and binding, and a sum of £50 has also been placed on fixed deposit with the Permanent Investment and Loan Association as an instalment towards liquidating the amount borrowed from the Tunnel Account; the balance in the Bank of New Zealand stands at £22 11s. 5d.

Papers.—1. "New *Coccidae*," by Mr. G. Brittin.

2. "The Increase in Size of certain *Crustacea* in High Latitudes," by Dr. Charles Chilton.

3. "Some Southern *Amphipoda* belonging to the Genus *Ampelisca*," by Dr. Charles Chilton.

4. "The New Zealand Species of the Amphipodan Genus *Elasmopus*," by Dr. Charles Chilton.

5. "Some *Amphipoda* from Lord Howe and Norfolk Islands," by Dr. Charles Chilton.

6. "The Fresh-water Crayfish of New Zealand," by Mr. G. E. Archey.

7. "The Occurrence in New Zealand of Myriapoda of the Genus *Scutigerella*, Order *Symphyla*," by Mr. G. E. Archey.

8. "A Note on the Occurrence of Petroleum in New Zealand," by Mr. R. Speight.

9. "The Chemistry of Flesh Foods, Part II," by Mr. A. M. Wright.

10. "Notes from the Canterbury College Mountain Biological Station, Cass.—No. 1: Introduction and General Description of Station," by Dr Charles Chilton.

11. "The Species and Varieties of *Phormium*," by Miss B. D. Cross.

12. "Pedunculate *Cirripedia* of New Zealand," by Mr. L. S. Jennings.

13. "Preliminary Note on the Protocorm of *Lycopodium laterale*," by Rev. J. E. Holloway.

14. "An Undescribed Species of *Cotula* from the Chatham Islands," by Dr. L. Cockayne, F.R.S.; communicated by Dr. Charles Chilton.

15. "Note on the Determination of Milk-fat," by Mr. A. M. Wright.

16. "Description of New Zealand *Lepidoptera*," by Mr. E. Meyrick; communicated by Dr. Chilton.

17. "Revision of New Zealand *Tineina*," by Mr. E. Meyrick, F.R.S.; communicated by Dr. Chilton.

Election of Officers for 1914.—President—Mr. A. D. Dobson; *Vice-Presidents*—Dr. W. P. Evans and Mr. L. Birks; *Hon. Secretary*—Mr. A. M. Wright; *Hon. Treasurer*—Mr. R. Speight; *Hon. Librarian*—Mr. E. G. Hogg; *Council*—Dr. Charles Chilton, Dr. C. Coleridge Farr, Dr. F. W. Hilgendorf, Mr. S. Page, Mr. W. F. Robinson, Mr. G. E. Archey; *Hon. Auditor*—Mr. G. E. Way, F.P.A.N.Z.

OTAGO INSTITUTE.

FIRST MEETING: *5th May, 1914.*

Dr. J. Malcolm, Vice-President, in the chair.

New Member.—Mr. C. E. Clarke.

Address.—"The Geology of Tahiti," by Dr. P. Marshall, F.G.S.

SPECIAL PUBLIC MEETING: *20th May, 1914.*

Mr. G. M. Thomson, M.P., in the chair.

Professor W. M. Davis, of Harvard University, delivered an address, illustrated with fine diagrams, on "The Origin of the Coral Reefs of Fiji."

SPECIAL PUBLIC MEETING: *23rd May, 1914.*

Mr. G. M. Thomson, M.P., in the chair.

An address on "The Fisheries of Canada and New Zealand: a Contrast" was given by Professor E. E. Prince, Commissioner of Fisheries, Canada.

SECOND MEETING: *2nd June, 1914.*

Mr. R. Gilkison, Vice-President, in the chair.

New Members.—Messrs. L. D. Coombs, A.R.I.B.A.; W. J. Kerr; J. L. Salmond; S. Solomon, K.C.; and Professor R. Jack, D.Sc.

Address.—"The Agricultural Development of the West Indies," by Mr. D. Tannock.

The paper dealt with the work that the Imperial Department of Agricultural Development is doing in the islands by means of its botanic station, its agricultural school, its travelling inspectors, and its experimental plots in the country districts. The second part of the paper was concerned more particularly with the island of Dominica and its industries.

THIRD MEETING: *7th July, 1914.*

Dr. J. Malcolm, Vice-President, in the chair.

Exhibits.—Fine metal castings of biological and botanical specimens, by Mr. C. E. Clarke.

Papers.—1. "*Oligochaetae* on the Kermadec Islands," by Dr. W. B. Benham, F.R.S.

2. " Note on the Littoral *Polychaetae* of the Kermadec Islands," by Dr. W. B. Benham, F.R.S.

3. " Dunedin Weather," by Mr. D. Tannock.

An interesting comparison of the local records, especially those for 1913, with the records from the other chief centres of the Dominion.

4. " How a Muscle works," by Dr. J. Malcolm.

A short address, illustrated by demonstrations with a frog's muscle, explaining simple and compound muscular movements.

5. " The Three Species of Rat found in New Zealand," by Dr. W. B. Benham, F.R.S.

FOURTH MEETING: *4th August, 1914.*

The President, Mr. F. W. Payne, in the chair.

New Members.—Professor F. W. Dunlop, M.A., Ph.D., and Mr. W. A. Thomson.

Address.—The President delivered his presidential address, entitled " Natural Sources of Power."

Papers.—1. " Notes on a Pure-white Form of *Anas superciliosa*," by Mr. D. L. Poppelwell.

2. " Notes of a Botanical Visit to Herekopere Island," by Mr. D. L. Poppelwell.

3. " Notes on the Plant Covering of the Garvie Mountains," by Mr. D. L. Poppelwell.

FIFTH MEETING: *1st September, 1914.*

The President, Mr. F. W. Payne, in the chair.

Address.—" The Shakespeare-Bacon Controversy," by Mr. T. W. Whitson.

An interesting account of the whole history of the controversy, and a very able exposition of the futility of the Baconian claims.

SIXTH MEETING: *6th October, 1914.*

The President, Mr. F. W. Payne, in the chair.

Papers and Addresses.—1. " The Food Value of New Zealand Carrageen," by Dr. J. Malcolm.

2. " Description of New Species of *Lepidoptera*," by Mr. A. Philpott; communicated by Dr. W. B. Benham, F.R.S.

3. " The Malay States and the Tin-mining Industry," by Mr. F. W. Payne.

4. " The Smelting of Tin," by Professor D. B. Waters.

SEVENTH MEETING: *1st December, 1914.*

Mr. R. Gilkison, Vice-President, in the chair.

Papers.—1. "A Remarkable Case of Bifurcation in *Lumbricus rubellus*," by Dr. W. B. Benham, F.R.S.

2. "On *Lumbricillus macquariensis*," by Dr. W. B. Benham, F.R.S.

3. "Notes on some New Zealand *Polychaetes*," by Dr. W. B. Benham, F.R.S.

4. "Cainozoic Fossils from near Oamaru," by Professor P. Marshall, D.Sc., F.G.S.

5. "The Geology of Tahiti," by Professor P. Marshall, D.Sc., F.G.S.

6. "Ambrym Island and its Recent Eruptions," by Professor P. Marshall, D.Sc., F.G.S.

7. "Graptolites from Golden Ridge, near Collingwood," by Dr. T. S. Hall; communicated by Dr. P. Marshall.

Annual Report.—The annual report and the balance-sheet for 1914 were read and adopted.

ABSTRACT OF ANNUAL REPORT.

During the year the Council has met nine times for the transaction of the business of the Institute.

The Council supported the Manawatu Philosophical Society and the New Zealand Forest and Bird Protection Society in their endeavours to induce the Government to adopt and pass a private Bill having for its object the extension of the boundaries of Tongariro National Park. The attention of all local Members of Parliament was drawn to the proposal, and their co-operation in the matter sought. As a result, presumably, of the efforts of this and kindred societies the Government has, by an Order in Council, we understand, enlarged the park to the desired extent.

It is to be regretted that the efforts made by the Institute last year to secure the restoration of the protection accorded to the fur seal in New Zealand waters have not borne fruit, as the present Government still adheres to its policy of licensing sealers to pursue their calling among the southern islands. If such a policy is persisted in, the extinction of the fur seal in these waters will, it is to be feared, be a matter of only a very few years.

During the year the Council, on behalf of the Institute, contributed the sum of £50 towards the sum required to purchase for the Museum the specimens placed there on deposit some years ago by the late Mr. Hamilton. The result has been a valuable addition to the collection of moa remains, for which the Otago University Museum has so long been noteworthy. A donation of £15 was also made to the Augustus Hamilton Memorial Fund, and one of three guineas to the Alfred Russell Wallace Memorial Fund.

During the year the New Zealand Institute has remitted to the incorporated societies for their consideration a proposal that each society should hereafter contribute 2s. 6d. per member to the funds of the Institute. Your Council, believing that the statutory grant received by the Institute is quite inadequate to enable it to carry on its work successfully, has agreed to the proposed levy being made for at least one year.

Meetings.—Seven ordinary and two special meetings of the Institute have been held during the year. At the ordinary meetings there have been read or received fifteen papers embodying the results of original research.

Of more general interest to members were the following addresses: "Natural Sources of Power" (presidential address), by Mr. F. W. Payne; "The Geology of Tahiti," by Professor P. Marshall, D.Sc.; "The Agricultural Development of the West Indies," by Mr. D. Tannock; "How a Muscle works," by Professor J. Malcolm, M.D.; and "The Shakespeare-Bacon Controversy," by Mr. T. W. Whitson, the last-named a paper of exceptional merit.

Taking advantage of the presence in Dunedin of two distinguished visiting scientists (Professor W. M. Davis, of Harvard University, and Professor E. E. Prince, Commissioner of Fisheries, Canada), your Council arranged for two special public meetings in the Y.M.C.A. Hall, Professor Davis speaking on "The Origin of the Coral Reefs of Fiji," on the 20th May, and Professor Prince on "The Fisheries of Canada and New

Zealand: a Contrast," on the 23rd May. These two meetings were very successful, both our own members and the general public attending them in satisfactory numbers.

The Institute has been called upon at its meetings during the past year to place on record its deep regret at the death of three of its former Presidents—Dr. J. H. Scott, Dr. John Shand, C.M.G., and Mr. J. C. Thomson. Dr. Scott, who was President as far back as 1885, had for over twenty years taken an active part in the work of the Institute, and had contributed to the Transactions original work of great value.

Technological Branch.—The year 1914 has been productive of good and useful work. A full course of seven ordinary meetings was held, at which valuable and interesting lectures were delivered.

Astronomical Branch.—Five ordinary meetings of the branch have been held during the season, when numerous important papers were read and discussed.

Presentations to the library have been made by Mr. E. B. M. Walmsley (books and magazines), and Mr. J. W. Milnes ("Observer's Atlas of the Heavens").

An arrangement has been made with the Wellington Philosophical Society (Astronomical Branch) for the exchange of papers read at the two societies. As a result, two papers have been forwarded from Dunedin to Wellington, and one, on "Variable Stars," has been received. It is hoped that this plan will be found of benefit to both societies.

During the year a transit instrument, as previously promised, was kindly handed over to the society by Mr. J. Blair Mason. The instrument has been repaired by Mr. Bremner, and is now erected, and will be oriented by Professor Park.

Membership.—During the year eight new members have been elected, three of whom entered through the Technological and one through the Astronomical Branch. On the other hand, twenty-seven members have either resigned or been struck off the membership list owing chiefly to removals from Dunedin, and six members (Dr. J. H. Scott, Dr. John Shand, and Messrs. John Blair, James Nichol, J. C. Thomson, and J. F. Woodhouse) have been removed by death. The membership roll, therefore, has suffered a net decrease of twenty-five, and now stands at 201.

Librarian's Report.—During the session twelve new works have been purchased, and six are on order with our agent. Of these, nine are technical works in zoology, botany, evolution, heredity, and so forth; three are geological; three on natural history in the popular sense, and are suitable for general readers who may be interested in the history of prehistoric or primitive man.

The Institute has also commenced to subscribe to a botanical periodical, "The New Phytologist," and is arranging to obtain the earlier volumes.

A number of works added are due to the generosity of certain gentlemen. Mr. E. B. M. Walmsley presented seven astronomical books, most of which are suitable for general reading, and two periodicals of a technical nature. Mr. J. W. Milnes presented a valuable atlas to the heavens. To Mr. F. H. Statham we are indebted for a large series of the back numbers of the Journal of the Institute of Civil Engineers, which should be useful to members of the Technological Branch. Owing to lack of accommodation, these are at present stored in the basement.

During the past year fifty-one volumes have been bound, most of which are periodicals and other serials.

Balance-sheet.—The balance-sheet, presented by the Treasurer (Mr. R. N. Vanes), showed a credit of £80 6s. 10d. The gross receipts totalled £859, including subscriptions amounting to £175, deposits at call amounting to £533 10s.

Election of Officers for 1915.—*President*—Mr. R. Gilkison; *Vice-Presidents*—Dr. P. Marshall and Dr. W. B. Benham; *Hon. Secretary*—Mr. E. J. Parr; *Hon. Treasurer*—Mr. R. N. Vanes; *Hon. Auditor*—Mr. H. Brasch; *Hon. Librarian*—Dr. Benham; *Council*—Dr. R. V. Fulton, Dr. J. K. H. Inglis, Dr. R. Jack, Dr. J. Malcolm, Messrs. H. Brasch, G. M. Thomson, and Professor J. Park.

TECHNOLOGICAL BRANCH.

First Meeting: *19th May, 1914.*

Mr. E. E. Stark in the chair.

Address.—"The Law of Building and Engineering Contracts," by Mr. H. Brasch.

The legal powers of local bodies, corporations, and joint-stock companies in regard to entering into contracts for erecting buildings were set forth very fully. The legal status and powers of architects were also ably summarized.

Second Meeting: *16th June, 1914.*

Professor D. B. Waters in the chair.

Paper.—"Sand Movements and Banks at the Entrance to the Otago Harbour," by Mr. J. B. Mason.

An interesting record of all the changes that have taken place in the configuration of the harbour-entrance since 1844, and a description of the means employed to control or prevent such changes; well illustrated by charts and lantern-slides.

Third Meeting: *21st July, 1914.*

Mr. E. E. Stark in the chair.

Paper.—"The Generation and Utilization of Electric Energy from Waipori," by Mr. E. E. Stark.

A full description of the Waipori power-generating apparatus, transmission-line, sub-stations, stand-by plant, and distributing system, with an analysis of the cost of the enterprise. Illustrated by a large number of slides.

Fourth Meeting: *18th August, 1914.*

Mr. E. E. Stark in the chair.

Paper.—"The Evolution of Domestic Architecture," by Mr. B. B. Hooper, A.R.I.B.A.

Fifth Meeting: *15th September, 1914.*

Mr. E. E. Stark in the chair.

Papers.—1. "Oils and Oil-testing," by Professor D. B. Waters.
2. "Indicator Diagrams and Steam Efficiencies," by Mr. R. McLintock.

Sixth Meeting: *20th October, 1914.*

Professor J. Park in the chair.

Paper.—"Friction and Lubrication," by Mr. E. E. Stark.

Seventh Meeting: *17th November, 1914.*

Professor J. Park in the chair.

Paper.—"Waterworks," by Mr. W. D. R. McCurdie.

EIGHTH MEETING: *15th December, 1914.*

Professor J. Park in the chair.

The annual report was read and adopted, and the following office-bearers for 1915 were elected: *Chairman*—Mr. J. B. Mason; *Vice-Chairmen*—Professors J. Park and D. B. Waters; *Hon. Secretary*—Mr. H. Brasch; *Committee*—Messrs. G. W. Davies, B. B. Hooper, W. D. R. McCurdie, R. McLintock, G. Simpson, and R. N. Vanes.

ASTRONOMICAL BRANCH.

FIRST MEETING: *26th May, 1914.*

Mr. R. Gilkison in the chair.

Address.—"Ball's Theory of the Ice Age," by Mr. R. Gilkison.

SECOND MEETING: *23rd June, 1914.*

Mr. R. Gilkison in the chair.

Address.—"The Characteristics of certain Familiar Stars," by the Rev. D. Dutton, F.G.S., F.R.A.S.

THIRD MEETING: *28th July, 1914.*

Mr. R. Gilkison in the chair.

Address.—"The Elimination of Errors in Astronomical Observations," by Dr. P. D. Cameron.

FOURTH MEETING: *25th August, 1914.*

Mr. R. Gilkison in the chair.

Address.—"The Glacial Period," by Professor P. Marshall, D.Sc., F.G.S.

FIFTH MEETING: *22nd September, 1914.*

Mr. R. Gilkison in the chair.

Papers.—1. "On the Deflection of the Plumb-line due to the Spheroidal Form of the Earth," by Mr. W. T. Neill.

2. "Recent Astronomy," by the Rev. P. W. Fairclough, F.R.A.S.

SIXTH MEETING: *27th October, 1914.*

Mr. R. Gilkison in the chair.

Paper.—"Southern Variable Stars," by Mr. Westland (by arrangement with the Wellington Philosophical Society, Astronomical Branch).

The annual report was read and adopted, and the following officers for 1915 were elected: *Chairman*—Mr. R. Gilkison; *Vice-Chairmen*—Professors J. Park and D. J. Richards, and Rev. D. Dutton, F.R.A.S.; *Hon. Secretary*—Mr. J. Bremner; *Committee*—Dr. P. D. Cameron, Messrs. H. Brasch, J. W. Milnes, W. T. Neill, and S. W. Wilson.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

First Meeting: *7th May, 1914.*

Mr. W. Dinwiddie, President, in the chair, and a number of members and the public.

New Members.—H. W. Lee and Rev. T. Richards.

Address.—"Heredity and Eugenics," by W. Dinwiddie.

The speaker gave the views of authorities on the subject, and an account of work undertaken in compiling statistics.

Hamilton Memorial.—The Council voted £5 in aid of this memorial.

Second Meeting: *5th June, 1914.*

Mr. W. Dinwiddie, President, in the chair, and fifty others.

Lecture.—"The Honey-bee and the Modern Honey Industry," by Mr. Bostock.

This was a description of the life and work of the bee and of the treatment of honey, and was illustrated by 160 of the author's own slides. In showing these the Institute's new arc lamp was used for the first time, and gave much satisfaction.

Third Meeting: *17th June, 1914.*

Mr. W. Dinwiddie, President, in the chair, and 100 others.

Address.—"The Evolution of Life," by Sir Robert Stout.

This was published in full in the *Hawke's Bay Herald.*

Fourth Meeting: *10th July, 1914.*

Mr. W. Dinwiddie, President, in the chair, and 70 others.

Address.—"The Southern Alps," by Mr. Mannering.

This was illustrated by many fine enlargements of scenes in the Southern Alps and by a series of beautiful slides.

Tongariro Park.—The Manawatu Philosophical Institute's action in trying to get the reserve increased was supported.

Fifth Meeting: *18th September, 1914.*

Mr. W. Dinwiddie, President, in the chair, and about thirty others.

Paper.—"The Navigation and Exploration of the Ancient Maori," by Mr. Skinner.

The author gave his views of the origin of the Maori, and explained how the journeys were made in the canoes.

SIXTH MEETING: *23rd October, 1914.*

Mr. W. Dinwiddie, President, in the chair, and twenty others.

Papers.—1. "La Perouse's Expedition and its Fate," by Mr. W. McCarthy.
2. "King Lear," by Mr. H. W. Lee.

ANNUAL MEETING: *11th December, 1914.*

Mr. W. Dinwiddie, President, in the chair, and a small number of members.

ANNUAL REPORT.

This shows a small addition to the membership and the loss of a few members.

Support was given to the Wellington Institute's proposal for a memorial to the late A. Hamilton, and to the Manawatu Institute's proposed increase in the Tongariro Park.

The balance-sheet shows a satisfactory credit balance.

Election of Officers for 1915.—*President*—F. Hutchinson; *Vice-President*—F. Heaton; *Secretary*—J. Niven; *Treasurer*—J. Wilson Craig; *Council*—W. Kerr, D. Strachan, T. Hyde, W. Dinwiddie, H. Hill, T. C. Moore; *Auditor*—J. Large; *Lanternist*—E. G. Loten.

MANAWATU PHILOSOPHICAL SOCIETY.

First Meeting: *19th March, 1914.*

Paper.—"The Evolution of the English House," by Mr. C. R. Ford.

Tracing its gradual development from early Saxon times to the present, with numerous lantern illustrations.

Second Meeting: *16th April, 1914.*

Paper.—"Some Interesting Facts in Connection with the Geology of New Zealand," by Mr. J. W. Poynton, S.M.

The paper spoke of the antiquity of the rock-formation of New Zealand, the frequency of faults therein; the peculiarities of the flora and fauna—specially mentioning among the latter the peripatus and the tuatara—and the evidence which they afforded of a land connection in prehistoric times with South America by way of the Antarctic Continent, and also with the tropical regions to the north.

Third Meeting: *21st May, 1914.*

Paper.—"The Effect of Wet and Dry Epochs upon Ancient Civilizations," by Mr. W. Welch, F.R.G.S.

The paper maintained the theory that the humidity of different regions of the earth varied by more or less regular pulsations, and supported the theory by the results of recent investigations into the physical geography of Transcaspia, Palestine, and the south-west of North America, and also by apparent variation in the growth of trees as shown by the variation in their rings. The theory, if true, would account for the disappearance of certain ancient civilizations.

Fourth Meeting: *18th June, 1914.*

Paper.—"Othello, Macbeth, and Hamlet: a Comparison and a Contrast," by Mr. G. D. Braik, M.A.

The paper, dealing chiefly with the working-out of the different temperaments and motives of the three protagonists, was illustrated by selected passages read by Mr. J. H. Primmer.

Fifth Meeting: *29th June, 1914.*

Lecture.—"Sun-spots and Solar Physics," by Mr. J. Taylor.

The paper maintained that the sun was simply "a vacuous central vortex where all physical characteristics have entirely vanished"; that so-called sun-spots were the shadows of aggregations of numerous small bodies moving in the line of vision between us and the sun.

Sixth Meeting: *8th July, 1914.*

Paper.—"The Evolution of Maori Art," by Mr. H. D. Skinner, B.A.

The paper, illustrated by numerous lantern-slides, showed the gradual development in the forms of Native weapons, instruments, and architecture.

Seventh Meeting: *17th September, 1914.*

Paper.—"Further Notes on the Geology of New Zealand," by Mr. J. W. Poynton, S.M.

Showing how the recent discoveries of fossil forms, both animal and vegetable, in Antarctica supported the theory of a land connection between that continent and New Zealand on the one hand, and South America on the other, during the Tertiary period.

Eighth Meeting: *15th October, 1914.*

Paper.—"Plant-life in the Solomon Islands," by the Ven. Archdeacon Comins, D.D.

After a brief sketch of the history of the islands from their discovery by Mendeña in 1567, the paper, which was illustrated by many exhibits and photographs, described the leading characteristics of the island flora, which bears a close affinity with that of Papua, with which the islands have probably at one time been connected.

Annual Meeting: *26th November, 1914.*

Abstract of Annual Report.

The report referred to the efforts which had been made by the Council during the past year to secure the enlargement of the Tongariro National Park, with a view to the preservation of the native bush, at present greatly endangered by the introduction of sawmills, &c., and also to the provision of better accommodation for tourists. Inquiries had also been made into the tenure of the land on the summit of Mount Wharite, with a view of getting it proclaimed as a scenic reserve; and the Council pressed upon their successors the urgent necessity of continuing the advocacy of both these measures.

The Museum was being slightly rearranged, on the advice of Mr. T. W. Kirk, F.L.S., in order to bring together the exhibits which illustrate the natural products and industries of the country, and thereby to increase their direct educational value. The time was fast approaching when increased and more secure accommodation must be provided if the Museum was to do its work properly.

Election of Officers for 1915.—*President*—Mr. J. W. Poynton, S.M.; *Vice-Presidents*—Messrs. J. L. Barnicoat and M. A. Eliott; *Officer in charge of the Observatory*—Mr. C. T. Salmon; *Secretary and Treasurer*—Mr. K. Wilson, M.A.; *Council*—Miss Ironside, M.A., and Messrs. R. Gardner, J. B. Gerrard, W. Park, H. D. Skinner, B.A., and J. E. Vernon, M.A.; *Auditor*—Mr. W. E. Bendall.

On the motion of the Secretary, seconded by Mr. Park, it was resolved, That the Council be authorized to contribute annually, if required, to the funds of the New Zealand Institute a sum not exceeding 2s. 6d. per member.

WANGANUI PHILOSOPHICAL SOCIETY.

SPECIAL MEETING : *8th December, 1913.*

Dr. Hatherly, President, in the chair.

Lecture.—" New Zealand Glaciers, Lakes, and Fiords," by Professor P. Marshall.

In addition to the members, a large number of friends attended this lecture, which was profusely illustrated with fine lantern-slides.

FIRST MEETING : *20th April, 1914.*

Rev. J. Ll. Dove, M.A., Vice-President, in the chair.

Address.—" The Aims of a Philosophical Society," by Dr. Hatherly.

The lecturer included in his paper an interesting account of the history and aims of the New Zealand Institute.

Paper.—" The Journeyings of Tamatea," by Mr. T. W. Downes.

SECOND MEETING : *13th May, 1914.*

Lecture.—" The Evolution of the English House," by Mr. C. R. Ford, F.R.G.S.

This lecture was illustrated by numerous lantern-slides, and the gradual development of the modern house under the influence of improving social conditions, and aided by absorption of ideas from all quarters, was fascinatingly traced from the one-apartment hut to the palatial structures of modern times.

THIRD MEETING : *8th June, 1914.*

Dr. Hatherly, President, in the chair.

Lecture.—" Shakespeare's Othello, Hamlet, and Macbeth : a Comparison and a Contrast," by Mr. G. D. Braik, M.A., Director of Education, Wanganui Education Board.

The lecture was illustrated by readings given by Mr. J. B. Reid.

FOURTH MEETING : *20th July, 1914.*

Dr. Hatherly, President, in the chair.

Papers.—1. " The Stars," by Mr. Thomas Allison.
2. " Some Notes on Bergson," by Mr. C. P. Brown, M.A., LL.B.
3. " R. L. Stevenson," by Mr. W. A. Armour, M.A., M.Sc.

Fifth Meeting: *24th August, 1914.*

Dr. Hatherly, President, in the chair.

Lecture.—"Sun-spots and Associated Solar Phenomena," by Mr. J. T. Ward, Hon. Director, Wanganui Observatory.

This lecture was illustrated with numerous splendid lantern-slides.

Sixth Meeting: *28th September, 1914.*

Dr. Hatherly, President, in the chair.

Address.—"Tolstoy's Attitude towards Modern Civilization," by Mr. H. E. Sturge, M.A., Oxon.

Mr. Sturge pointed out the fundamental character of Tolstoy's criticism, and suggested that it at least merited serious consideration.

Seventh Meeting: *12th October, 1914.*

Mr. H. W. Hesse, M.A., in the chair.

Exhibit.—Monochrome photographic lantern-slides of British scenery, by Mr. James Crichton.

Paper.—"The Scientific Principles of Colour Photography," by Mr. W. A. Armour, M.A., M.Sc.

Exhibit.—Colour photography, including lantern-slides, &c., lent by Mr. James Crichton, Mr. E. H. Clark, Mr. T. W. Downes, and Mr. T. Allison, representing the following processes: Sanger-Shepherd, Lumière, Thames, and Paget.

Eighth Meeting: *26th October, 1914.*

Dr. Hatherly, President, in the chair.

Lecture.—"Problems of Soil-fertility," by Mr. L. J. Wild, M.A., F.G.S.

Papers.—1. "The Soils of Wairau Plain, Marlborough," by Mr. L. J. Wild, M.A., F.G.S.

2. "Some Recent Theories of Plant-nutrition," by Mr. L. J. Wild, M.A., F.G.S., and Mr. W. S. Hill, B.Agric.

Ninth Meeting: *23rd November, 1914.*

Dr. Hatherly, President, in the chair.

Lecture.—"Sidelights on the Life-history and Habits of the Insect," by Mr. Morris N. Watt, F.E.S.

The lecture was illustrated with numerous lantern-slides.

Paper.—"Contributions to the Study of New Zealand Etomology from an Economical and a Biological Standpoint": Nos. 1, 2, and 3, by Mr. Morris N. Watt, F.E.S.; and Nos. 4, 5, 6, and 7, by Messrs. Morris N. Watt, F.E.S., and David Miller.

TENTH MEETING: *7th December, 1914.*

Mr. C. P. Brown, M.A., LL.B., in the chair.

Lecture.—"Experimental Psychology," by Professor Hunter, M.A., M.Sc.

ANNUAL MEETING: *27th January, 1915.*

The annual report and balance-sheet were adopted.

The financial position was satisfactory, showing a balance of £34 8s. 2d., after paying a subsidy to the Museum of £20 8s. 2d.

ABSTRACT OF REPORT.

Membership.—The roll of the society includes at date sixty-five ordinary and sixty-one associate members. During the year the society has had to regret the loss of two members of its Council through their leaving Wanganui—the Rev. J. Ll. Dove, Vice-President, and Mr. H. B. Watson, member of Council. Both gentlemen were officers of the society from its inception, and took an active part in its work, and their removal will be much felt. By the lamented death of Mr. G. D. Braik, Director of Education to the Wanganui Education Board, our society has suffered a severe blow. Mr. Braik contributed regularly papers of great interest and value on literary and educational subjects, and his contributions to our discussions were always useful and stimulating. Mr. J. T. Ward, whose work on behalf of the society has been most useful, was elected a life member, the first member to be so honoured.

Meetings.—Eleven meetings were held, at which fourteen papers were read and numerous exhibits shown, the lantern being used successfully at six meetings. The contributors were in general our own members, but the society was placed under a debt of gratitude by Professor Marshall and by Professor Hunter for their valuable lectures.

Election of Officers for 1915.—President—H. R. Hatherly, M.R.C.S.: *Vice-Presidents*—J. T. Ward; H. Latter, M.A.: *Council*—T. Allison; J. A. Neame, B.A.; Morris N. Watt, F.E.S.; W. A. Armour, M.A., M.Sc.; C. P. Brown, M.A., LL.B.; T. W. Downes; R. Murdoch; H. W. Hesse, M.A., B.Sc., F.L.S.: *Hon. Treasurer*—F. P. Talboys: *Hon. Secretary*—J. P. Williamson: *Representative on Board of Governors, New Zealand Institute*—Dr. Hatherly.

NELSON INSTITUTE.

ANNUAL MEETING: *27th April, 1914.*

Mr. T. A. H. Field, President, in the chair.

The annual report and balance-sheet was adopted. The financial position showed a credit balance of £2 7s. 11d.

ABSTRACT OF REPORT.

Reference was made to the revival of the Scientific Branch and to the series of meetings held during the year. At one of the meetings an instructive lecture was delivered by Mr. John Evershed, of Kodaikanal Observatory, India. The lecturer dealt with the subject of sun-spots, but incidentally he made numerous references to methods of observation, &c. Mr. Evershed stated that the scientific world owed a debt of gratitude to Mr. Thomas Cawthron for his offer of a solar observatory. The Royal Astronomical Society had passed a resolution appreciating the gift. The observatory would be admirably placed at Nelson, and the results obtained would be most useful.

Meetings.—The following papers have been read during this year (1914): Mr. F. G. Gibbs, M.A., on "The Proposed Cawthron Observatory, and explaining Mr. J. Evershed's Methods of Observation."

Mr. W. F. Worley read two papers at successive monthly meetings, dealing with the bulletin on the Dun Mountain district, in which his observations led him to differ materially from the conclusions of those responsible for the bulletin.

Mr. F. V. Knapp dealt with "Shell-breaking Implements of the Maori," and exhibited specimens from Rabbit Island. It was decided to forward the paper for publication in the Transactions.

Mr. E. L. Morley showed a cardboard model illustrating the relation of the orbit of the recent comet to the orbit of the earth.

Mr. Frank Whitwell gave an account of various rusts found in plants in the Nelson district.

Mr. H. P. Washbourn gave an interim report on his investigations into the habits of the New Zealand eels.

Museum.—Thanks to the generosity of Mr. Thomas Cawthron, new cases with plate-glass fronts have been provided, and the exhibits are now shown to advantage. The attendance of visitors has been very satisfactory.

The Atkinson Observatory.—Mr. Morley continues in charge, and he reports a good attendance of visitors during the year.

APPENDIX.

NEW ZEALAND INSTITUTE ACTS.

NEW ZEALAND INSTITUTE ACT, 1903.

The following Act reconstituting the Institute was passed by Parliament :—

1903, No. 48.

An Act to reconstitute the New Zealand Institute.

[*18th November, 1903.*

Whereas it is desirable to reconstitute the New Zealand Institute with a view to connecting it more closely with the affiliated institutions :

Be it therefore enacted by the General Assembly of New Zealand in Parliament assembled, and by the authority of the same, as follows :—

1. The Short Title of this Act is the New Zealand Institute Act, 1903.

2. The New Zealand Institute Act, 1867, is hereby repealed.

3. (1.) The body hitherto known as the New Zealand Institute (hereinafter referred to as "the Institute") shall consist of the Auckland Institute, the Wellington Philosophical Society, the Philosophical Institute of Canterbury, the Otago Institute, the Hawke's Bay Philosophical Institute, the Nelson Institute, the Westland Institute, the Southland Institute, and such others as may hereafter be incorporated in accordance with regulations to be made by the Board of Governors as hereinafter mentioned.

(2.) Members of the above-named incorporated societies shall be *ipso facto* members of the Institute.

4. The control and management of the Institute shall be in the hands of a Board of Governors, constituted as follows :—

The Governor ;

The Colonial Secretary ;

Four members to be appointed by the Governor in Council during the month of December, one thousand nine hundred and three, and two members to be similarly appointed during the month of December in every succeeding year ;

Two members to be appointed by each of the incorporated societies at Auckland, Wellington, Christchurch, and Dunedin during the month of December in each alternate year ;

One member to be appointed by each of the other incorporated societies during the month of December in each alternate year.

5. (1.) Of the members appointed by the Governor in Council two shall retire annually on the appointment of their successors ; the first two members to retire shall be decided by lot, and thereafter the two members longest in office without reappointment shall retire.

(2.) Subject to the provisions of the last preceding subsection, the appointed members of the Board shall hold office until the appointment of their successors.

6. The Board of Governors as above constituted shall be a body corporate, by the name of the "New Zealand Institute," and by that name they shall have perpetual succession and a common seal, and may sue and be sued, and shall have power and authority to take, purchase, and hold lands for the purposes hereinafter mentioned.

7. (1.) The Board of Governors shall have power to appoint a fit person, to be known as the "President," to superintend and carry out all necessary work in connection with the affairs of the Institute, and to provide him with such further assistance as may be required.

(2.) It shall also appoint the President or some other fit person to be editor of the Transactions of the Institute, and may appoint a committee to assist him in the work of editing the same.

(3.) It shall have power to make regulations under which societies may become incorporated to the Institute, and to declare that any incorporated society shall cease to be incorporated if such regulations are not complied with, and such regulations on being published in the *Gazette* shall have the force of law.

(4.) The Board may receive any grants, bequests, or gifts of books or specimens of any kind whatsoever for the use of the Institute, and dispose of them as it thinks fit.

(5.) The Board shall have control of the property hereinafter vested in it, and of any additions hereafter made thereto, and shall make regulations for the management of the same, for the encouragement of research by the members of the Institute, and in all matters, specified or unspecified, shall have power to act for and on behalf of the Institute.

8. Any casual vacancy on the Board of Governors, howsoever caused, shall be filled within three months by the society or authority that appointed the member whose place has become vacant, and if not filled within that time the vacancy shall be filled by the Board of Governors.

9. (1.) The first annual meeting of the Board of Governors hereinbefore constituted shall be held at Wellington on some day in the month of January, one thousand nine hundred and four, to be fixed by the Governor, and annual meetings of the Board shall be regularly held thereafter during the month of January in each year, the date and place of such annual meeting to be fixed at the previous annual meeting.

(2.) The Board of Governors may meet during the year at such other times and places as it deems necessary.

(3.) At each annual meeting the President shall present to the meeting a report of the work of the Institute for the year preceding, and a balance-sheet, duly audited, of all sums received and paid on behalf of the Institute.

10. The Board of Governors may from time to time, as it sees fit, make arrangements for the holding of general meetings of members of the Institute, at times and places to be arranged, for the reading of scientific papers, the delivery of lectures, and for the general promotion of science in the colony by any means that may appear desirable.

11. The Colonial Treasurer shall, without further appropriation than this Act, pay to the Board of Governors the annual sum of five hundred pounds, to be applied in or towards payment of the general current expenses of the Institute.

12. (1.) On the appointment of the first Board of Governors under this Act the Board of Governors constituted under the Act hereby repealed shall cease to exist, and the property then vested in, or belonging to, or under the control of that Board shall be vested in His Majesty for the use and benefit of the public.

(2.) On the recommendation of the President of the Institute the Governor may at any time hereinafter, by Order in Council, declare that any part of such property specified in the Order shall be vested in the Board constituted under this Act.*

13. All regulations, together with a copy of the Transactions of the Institute, shall be laid upon the table of both Houses of Parliament within twenty days after the meeting thereof.

NEW ZEALAND INSTITUTE ACT, 1908.

1908, No. 130.

An Act to consolidate certain Enactments of the General Assembly relating to the New Zealand Institute.

Be it enacted by the General Assembly of New Zealand in Parliament assembled, and by the authority of the same, as follows:—

1. (1.) The Short Title of this Act is the New Zealand Institute Act, 1908.

(2.) This Act is a consolidation of the enactments mentioned in the Schedule hereto, and with respect to those enactments the following provisions shall apply:—

(*a.*) The Institute and Board respectively constituted under those enactments, and subsisting on the coming into operation of this Act, shall be deemed to be the same Institute and Board respectively constituted under this Act without any change of constitution or corporate entity or otherwise; and the members thereof in office on the coming into operation of this Act shall continue in office until their successors under this Act come into office.

(*b.*) All Orders in Council, regulations, appointments, societies incorporated with the Institute, and generally all acts of authority which originated under the said enactments or any enactment thereby repealed, and are subsisting or in force on the coming into operation of this Act, shall enure for the purposes of this Act as fully and effectually as if they had originated under the corresponding provisions of this Act, and accordingly shall, where necessary, be deemed to have so originated.

(*c.*) All property vested in the Board constituted as aforesaid shall be deemed to be vested in the Board established and recognized by this Act.

(*d.*) All matters and proceedings commenced under the said enactments, and pending or in progress on the coming into operation of this Act, may be continued, completed, and enforced under this Act.

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* See *New Zealand Gazette*, 1st September, 1904.

2. (1.) The body now known as the New Zealand Institute (hereinafter referred to as "the Institute") shall consist of the Auckland Institute, the Wellington Philosophical Society, the Philosophical Institute of Canterbury, the Otago Institute, the Hawke's Bay Philosophical Institute, the Nelson Institute, the Westland Institute, the Southland Institute, and such others as heretofore have been or may hereafter be incorporated therewith in accordance with regulations heretofore made or hereafter to be made by the Board of Governors.

(2.) Members of the above-named incorporated societies shall be *ipso facto* members of the Institute.

3. The control and management of the Institute shall be vested in a Board of Governors (hereinafter referred to as "the Board"), constituted as follows:—

The Governor:

The Minister of Internal Affairs:

Four members to be appointed by the Governor in Council, of whom two shall be appointed during the month of December in every year:

Two members to be appointed by each of the incorporated societies at Auckland, Wellington, Christchurch, and Dunedin during the month of December in each alternate year; and the next year in which such an appointment shall be made is the year one thousand nine hundred and nine:

One member to be appointed by each of the other incorporated societies during the month of December in each alternate year; and the next year in which such an appointment shall be made is the year one thousand nine hundred and nine.

4. (1.) Of the members appointed by the Governor in Council, the two members longest in office without reappointment shall retire annually on the appointment of their successors.

(2.) Subject to the last preceding subsection, the appointed members of the Board shall hold office until the appointment of their successors.

5. The Board shall be a body corporate by the name of the "New Zealand Institute," and by that name shall have perpetual succession and a common seal, and may sue and be sued, and shall have power and authority to take, purchase, and hold lands for the purposes hereinafter mentioned.

6. (1.) The Board shall have power to appoint a fit person, to be known as the "President," to superintend and carry out all necessary work in connection with the affairs of the Institute, and to provide him with such further assistance as may be required.

(2.) The Board shall also appoint the President or some other fit person to be editor of the Transactions of the Institute, and may appoint a committee to assist him in the work of editing the same.

(3.) The Board shall have power from time to time to make regulations under which societies may become incorporated with the Institute, and to declare that any incorporated society shall cease to be incorporated if such regulations are not complied with; and such regulations on being published in the *Gazette* shall have the force of law.

(4.) The Board may receive any grants, bequests, or gifts of books or specimens of any kind whatsoever for the use of the Institute, and dispose of them as it thinks fit.

(5.) The Board shall have control of the property from time to time vested in it or acquired by it; and shall make regulations for the

management of the same, and for the encouragement of research by the members of the Institute; and in all matters, specified or unspecified, shall have power to act for and on behalf of the Institute.

7. (1.) Any casual vacancy in the Board, howsoever caused, shall be filled within three months by the society or authority that appointed the member whose place has become vacant, and if not filled within that ime the vacancy shall be filled by the Board.

(2.) Any person appointed to fill a casual vacancy shall only hold office for such period as his predecessor would have held office under this Act.

8. (1.) Annual meetings of the Board shall be held in the month of January in each year, the date and place of such annual meeting to be fixed at the previous annual meeting.

(2.) The Board may meet during the year at such other times and places as it deems necessary.

(3.) At each annual meeting the President shall present to the meeting a report of the work of the Institute for the year preceding, and a balance-sheet, duly audited, of all sums received and paid on behalf of the Institute.

9. The Board may from time to time, as it sees fit, make arrangements for the holding of general meetings of members of the Institute, at times and places to be arranged, for the reading of scientific papers, the delivery of lectures, and for the general promotion of science in New Zealand by any means that may appear desirable.

10. The Minister of Finance shall from time to time, without further appropriation than this Act, pay to the Board the sum of five hundred pounds in each financial year, to be applied in or towards payment of the general current expenses of the Institute.

11. Forthwith upon the making of any regulations or the publication of any Transactions, the Board shall transmit a copy thereof to the Minister of Internal Affairs, who shall lay the same before Parliament if sitting, or if not, then within twenty days after the commencement of the next ensuing session thereof.

SCHEDULE.

Enactments consolidated.

1903, No. 48.—The New Zealand Institute Act, 1903.

REGULATIONS.

THE following are the regulations of the New Zealand Institute under the Act of 1903:—*

The word "Institute" used in the following regulations means the New Zealand Institute as constituted by the New Zealand Institute Act, 1903.

INCORPORATION OF SOCIETIES.

1. No society shall be incorporated with the Institute under the provisions of the New Zealand Institute Act, 1903, unless such society shall consist of not less than twenty-five members, subscribing in the aggregate

* *New Zealand Gazette*, 14th July, 1904.

a sum of not less than £25 sterling annually for the promotion of art, science, or such other branch of knowledge for which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the President for the time being of the society.

2. Any society incorporated as aforesaid shall cease to be incorporated with the Institute in case the number of the members of the said society shall at any time become less than twenty-five, or the amount of money annually subscribed by such members shall at any time be less than £25.

3. The by-laws of every society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of the annual revenue in or towards the formation or support of some local public museum or library, or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the New Zealand Institute.

4. Any society incorporated as aforesaid which shall in any one year fail to expend the proportion of revenue specified in Regulation No. 3 aforesaid in manner provided shall from henceforth cease to be incorporated with the Institute.

Publications.

5. All papers read before any society for the time being incorporated with the Institute shall be deemed to be communications to the Institute, and then may be published as Proceedings or Transactions of the Institute, subject to the following regulations of the Board of the Institute regarding publications :—

(*a*.) The publications of the Institute shall consist of—

(1.) A current abstract of the proceedings of the societies for the time being incorporated with the Institute, to be intituled "Proceedings of the New Zealand Institute";

(2.) And of transactions comprising papers read before the incorporated societies (subject, however, to selection as hereinafter mentioned), and of such other matter as the Board of Governors shall from time to time determine to publish, to be intituled "Transactions of the New Zealand Institute."

(*b*.) The Board of Governors shall determine what papers are to be published.

(*c*.) Papers not recommended for publication may be returned to their authors if so desired.

(*d*.) All papers sent in for publication must be legibly written, typewritten, or printed.

(*e*.) A proportional contribution may be required from each society towards the cost of publishing Proceedings and Transactions of the Institute.

(*f*.) Each incorporated society will be entitled to receive a proportional number of copies of the Transactions and Proceedings of the New Zealand Institute, to be from time to time fixed by the Board of Governors.

Management of the Property of the Institute.

6. All property accumulated by or with funds derived from incorporated societies, and placed in charge of the Institute, shall be vested in the Institute, and be used and applied at the discretion of the Board of

Governors for public advantage, in like manner with any other of the property of the Institute.

7. All donations by societies, public Departments, or private individuals to the Institute shall be acknowledged by a printed form of receipt and shall be entered in the books of the Institute provided for that purpose, and shall then be dealt with as the Board of Governors may direct.

Honorary Members.

8. The Board of Governors shall have power to elect honorary members (being persons not residing in the Colony of New Zealand), provided that the total number of honorary members shall not exceed thirty.

9. In case of a vacancy in the list of honorary members, each incorporated society, after intimation from the Secretary of the Institute, may nominate for election as honorary member one person.

10. The names, descriptions, and addresses of persons so nominated, together with the grounds on which their election as honorary members is recommended, shall be forthwith forwarded to the President of the New Zealand Institute, and shall by him be submitted to the Governors at the next succeeding meeting.

General Regulations.

11. Subject to the New Zealand Institute Act, 1908, and to the foregoing rules, all societies incorporated with the Institute shall be entitled to retain or alter their own form of constitution and the by-laws for their own management, and shall conduct their own affairs.

12. Upon application signed by the President and countersigned by the Secretary of any society, accompanied by the certificate required under Regulation No. 1, a certificate of incorporation will be granted under the seal of the Institute, and will remain in force as long as the foregoing regulations of the Institute are complied with by the society.

13. In voting on any subject the President is to have a deliberate as well as a casting vote.

14. The President may at any time call a meeting of the Board, and shall do so on the requisition in writing of four Governors.

15. Twenty-one days' notice of every meeting of the Board shall be given by posting the same to each Governor at an address furnished by him to the Secretary.

16. In case of a vacancy in the office of President, a meeting of the Board shall be called by the Secretary within twenty-one days to elect a new President.

17. The Governors for the time being resident or present in Wellington shall be a Standing Committee for the purpose of transacting urgent business and assisting the officers.

18. The Standing Committee may appoint persons to perform the duties of any other office which may become vacant. Any such appointment shall hold good until the next meeting of the Board, when the vacancy shall be filled.

19. The foregoing regulations may be altered or amended at any annual meeting, provided that notice be given in writing to the Secretary of the Institute not later than the 30th November.

THE HUTTON MEMORIAL MEDAL AND RESEARCH FUND.

Declaration of Trust.

This deed, made the fifteenth day of February, one thousand nine hundred and nine (1909), between the New Zealand Institute of the one part, and the Public Trustee of the other part: Whereas the New Zealand Institute is possessed of a fund consisting now of the sum of five hundred and fifty-five pounds one shilling (£555 1s.), held for the purposes of the Hutton Memorial Medal and Research Fund on the terms of the rules and regulations made by the Governors of the said Institute, a copy whereof is hereto annexed: And whereas the said money has been transferred to the Public Trustee for the purposes of investment, and the Public Trustee now holds the same for such purposes, and it is expedient to declare the trusts upon which the same is held by the Public Trustee:

Now this deed witnesseth that the Public Trustee shall hold the said moneys and all other moneys which shall be handed to him by the said Governors for the same purposes upon trust from time to time to invest the same upon such securities as are lawful for the Public Trustee to invest on, and to hold the principal and income thereof for the purposes set out in the said rules hereto attached.

And it is hereby declared that it shall be lawful for the Public Trustee to pay all or any of the said moneys, both principal and interest, to the Treasurer of the said New Zealand Institute upon being directed so to do by a resolution of the Governors of the said Institute, and a letter signed by the Secretary of the said Institute enclosing a copy of such resolution certified by him and by the President as correct shall be sufficient evidence to the Public Trustee of the due passing of such resolution: And upon receipt of such letter and copy the receipt of the Treasurer for the time being of the said Institute shall be a sufficient discharge to the Public Trustee: And in no case shall the Public Trustee be concerned to inquire into the administration of the said moneys by the Governors of the said Institute.

As witness the seals of the said parties hereto, the day and year hereinbefore written.

Resolutions of Board of Governors.

Resolved by the Board of Governors of the New Zealand Institute that—

1. The funds placed in the hands of the Board by the committee of subscribers to the Hutton Memorial Fund be called "The Hutton Memorial Research Fund," in memory of the late Captain Frederick Wollaston Hutton, F.R.S. Such fund shall consist of the moneys subscribed and granted for the purpose of the Hutton Memorial, and all other funds which may be given or granted for the same purpose.

2. The funds shall be vested in the Institute. The Board of Governors of the Institute shall have the control of the said moneys, and may invest the same upon any securities proper for trust-moneys.

3. A sum not exceeding £100 shall be expended in procuring a bronze medal to be known as "The Hutton Memorial Medal."

4. The fund, or such part thereof as shall not be used as aforesaid, shall be invested in such securities as aforesaid as may be approved of by the Board of Governors, and the interest arising from such investment shall be used for the furtherance of the objects of the fund.

5. The Hutton Memorial Medal shall be awarded from time to time by the Board of Governors, in accordance with these regulations, to persons who have made some noticeable contribution in connection with the zoology, botany, or geology of New Zealand.

6. The Board shall make regulations setting out the manner in which the funds shall be administered. Such regulations shall conform to the terms of the trust.

7. The Board of Governors may, in the manner prescribed in the regulations, make grants from time to time from the accrued interest to persons or committees who require assistance in prosecuting researches in the zoology, botany, or geology of New Zealand.

8. There shall be published annually in the "Transactions of the New Zealand Institute" the regulations adopted by the Board as aforesaid, a list of the recipients of the Hutton Memorial Medal, a list of the persons to whom grants have been made during the previous year, and also, where possible, an abstract of researches made by them.

Regulations under which the Hutton Memorial Medal shall be awarded and the Research Fund administered.

1. Unless in exceptional circumstances, the Hutton Memorial Medal shall be awarded not oftener than once in every three years; and in no case shall any medal be awarded unless, in the opinion of the Board, some contribution really deserving of the honour has been made.

2. The medal shall not be awarded for any research published previous to the 31st December, 1906.

3. The research for which the medal is awarded must have a distinct bearing on New Zealand zoology, botany, or geology.

4. The medal shall be awarded only to those who have received the greater part of their education in New Zealand or who have resided in New Zealand for not less than ten years.

5. Whenever possible, the medal shall be presented in some public manner.

6. The Board of Governors may, at an annual meeting, make grants from the accrued interest of the fund to any person, society, or committee for the encouragement of research in New Zealand zoology, botany, or geology.

7. Applications for such grants shall be made to the Board before the 30th September.

8. In making such grants the Board of Governors shall give preference to such persons as are defined in regulation 4.

9. The recipients of such grants shall report to the Board before the 31st December in the year following, showing in a general way how the grant has been expended and what progress has been made with the research.

10. The results of researches aided by grants from the fund shall, where possible, be published in New Zealand.

11. The Board of Governors may from time to time amend or alter the regulations, such amendments or alterations being in all cases in conformity with resolutions 1 to 4.

Award of the Hutton Memorial Medal.

1911. Professor W. B. Benham, D.Sc., F.R.S., University of Otago—For researches in New Zealand zoology.

1914. Dr. L. Cockayne, F.R.S., F.L.S.—For researches on the ecology of New Zealand plants.

Grants from the Hutton Memorial Research Fund.

1915. (1.) To Dr. C. A. Cotton—£15 as a contribution towards his travelling-expenses in an investigation of the physiographic features of the New Zealand coast.*

(2.) To Mr. W. R. B. Oliver—£15 to defray expenses of travelling and apparatus for a visit to Lord Howe Island undertaken in November, 1913.

HECTOR MEMORIAL RESEARCH FUND.

Declaration of Trust.

This deed, made the thirty-first day of July, one thousand nine hundred and fourteen, between the New Zealand Institute, a body corporate duly incorporated by the New Zealand Institute Act, 1908, of the one part, and the Public Trustee of the other part: Whereas by a declaration of trust dated the twenty-seventh day of January, one thousand nine hundred and twelve, after reciting that the New Zealand Institute was possessed of a fund consisting of the sum of £1,045 10s. 2d., held for the purposes of the Hector Memorial Research Fund on the terms of the rules and regulations therein mentioned, which said moneys had been handed to the Public Trustee for investment, it was declared (*inter alia*) that the Public Trustee should hold the said moneys and all other moneys which should be handed to him by the said Governors of the Institute for the same purpose upon trust from time to time, to invest the same in the common fund of the Public Trust Office, and to hold the principal and income thereof for the purposes set out in the said rules and regulations in the said deed set forth: And whereas the said rules and regulations have been amended by the Governors of the New Zealand Institute, and as amended are hereinafter set forth: And whereas it is expedient to declare that the said moneys are held by the Public Trustee upon the trusts declared by the said deed of trust and for the purposes set forth in the said rules and regulations as amended as aforesaid:

Now this deed witnesseth and it is hereby declared that the Public Trustee shall hold the said moneys and all other moneys which shall be handed to him by the said Governors for the same purpose upon trust from time to time to invest the same in the common fund of the Public Trust Office, and to hold the principal and income thereof for the purposes set out in the said rules and regulations hereinafter set forth:

And it is hereby declared that it shall be lawful for the Public Trustee to pay, and he shall pay, all or any of the said moneys, both principal and interest, to the Treasurer of the said New Zealand Institute upon being directed to do so by a resolution of the Governors of

* This grant has been surrendered by Dr. Cotton.

the said Institute, and a letter signed by the Secretary of the said Institute enclosing a copy of such resolution certified by him and by the President as correct shall be sufficient evidence to the Public Trustee of the due passing of such resolution: And upon receipt of such letter and copy the receipt of the Treasurer for the time being of the said Institute shall be a sufficient discharge to the Public Trustee: And in no case shall the Public Trustee be concerned to inquire into the administration of the said moneys by the Governors of the said Institute.

As witness the seals of the said parties hereto, the day and year first hereinbefore written.

Rules and Regulations made by the Governors of the New Zealand Institute in relation to the Hector Memorial Research Fund.

1. The funds placed in the hands of the Board by the Wellington Hector Memorial Committee be called "The Hector Memorial Research Fund," in memory of the late Sir James Hector, K.C.M.G., F.R.S. The object of such fund shall be the encouragement of scientific research in New Zealand, and such fund shall consist of the moneys subscribed and granted for the purpose of the memorial and all other funds which may be given or granted for the same purpose.

2. The funds shall be vested in the Institute. The Board of Governors of the Institute shall have the control of the said moneys, and may invest the same upon any securities proper for trust-moneys.

3. A sum not exceeding one hundred pounds (£100) shall be expended in procuring a bronze medal, to be known as the Hector Memorial Medal.

4. The fund, or such part thereof as shall not be used as aforesaid, shall be invested in such securities as may be approved by the Board of Governors, and the interest arising from such investment shall be used for the furtherance of the objects of the fund by providing thereout a prize for the encouragement of such scientific research in New Zealand of such amount as the Board of Governors shall from time to time determine.

5. The Hector Memorial Medal and Prize shall be awarded annually by the Board of Governors.

6. The prize and medal shall be awarded by rotation for the following subjects, namely—(1) Botany, (2) chemistry, (3) ethnology, (4) geology, (5) physics (including mathematics and astronomy), (6) zoology (including animal physiology).

In each year the medal and prize shall be awarded to that investigator who, working within the Dominion of New Zealand, shall in the opinion of the Board of Governors have done most towards the advancement of that branch of science to which the medal and prize are in such year allotted.

7. Whenever possible the medal shall be presented in some public manner.

Award of the Hector Memorial Research Fund.

1912. L. Cockayne, Ph.D., F.L.S., F.R.S.—For researches in New Zealand botany.
1913. T. H. Easterfield, M.A., Ph.D.—For researches in chemistry.
1914. Elsdon Best—For researches in New Zealand ethnology.
1915. P. Marshall, M.A., D.Sc., F.G.S.—For researches in New Zealand geology.

THE CARTER BEQUEST.

Extracts from the Will of Charles Rooking Carter.

This is the last will and testament of me, Charles Rooking Carter, of Wellington, in the Colony of New Zealand, gentleman.

I revoke all wills and testamentary dispositions heretofore made by me, and declare this to be my last will and testament.

I give to the Colonial Museum in Wellington the large framed photographs of the members of the General Assembly in the House of Representatives in the year 1860, and the framed pencil sketch of the old House of Commons, and the framed invitation-card to the Lord Mayor's dinner.

As regards the following books, of which I am the author, and which are now stored in three boxes—namely, (1) "The Life and Recollections of a New Zealand Colonist," (2) "A Historical Sketch of New Zealand Loans," and (3) "Round the World Leisurely"—I direct that my executor shall retain possession of the same for a period of seven years, commencing from the date of my death, and that at the end of such period my executor shall place the same in the hands of Messrs. Whitcombe and Tombs (Limited) or some other capable and responsible booksellers in the City of Wellington, for sale, and so that the same shall be sold at such a price as will yield to my estate not less than six shillings per volume in respect of the first-named and second-named, and two shillings and sixpence in respect of the last-named works; and I further authorize my executor to sell and dispose of the copyright or right to reprint such works; and I direct that the moneys to be derived from the sale of such works and the privileges connected therewith shall be added to the sum provided for the purchase of a telescope as hereinafter mentioned.

I direct my executor to subscribe the sum of fifty pounds towards the erection of a suitable brick room in which to house the priceless collection of books on New Zealand some time since given by me to the Colonial Museum and the New Zealand Institute.

I give and devise unto the Public Trustee appointed under and in pursuance of an Act of the General Assembly of New Zealand intituled the Public Trust Office Act, 1894 (hereinafter called "my trustee"), all the rest, residue, and remainder of my property whatsoever and wheresoever situate, both real and personal, and whether in possession, reversion, expectancy, or remainder, upon trust, as to my freehold property at East Taratahi, containing by admeasurement two thousand one hundred and seventy-two acres, and being and comprising the whole of the land included in certificate of title, volume 51, folio 79, of the books of the District Land Registrar for the Registration District of Welling-

ton (save and except such part of the said land, being portion of the section numbered 117 in the Taratahi Plain Block, as is hereinafter devised to my trustee for the purposes hereinafter appearing), and direct that my Trustee shall stand possessed of the same lands upon trust, to let and manage the same, and to pay and apply the rents and annual income in manner following, namely:—

And as to all the residue and remainder (if any) of the said net proceeds of the sale, conversion, and getting-in of my estate as aforesaid, my trustee shall transfer the same to the Governors for the time being of the New Zealand Institute at Wellington, to form the nucleus of a fund for the erection in or near Wellington aforesaid, and the endowment of a Professor and staff, of an Astronomic Observatory fitted with telescope and other suitable instruments for the public use and benefit of the colony, and in the hope that such fund may be augmented by gifts from private donors, and that the Observatory may be subsidized by the Colonial Government; and without imposing any duty or obligation in regard thereto I would indicate my wish that the telescope may be obtained from the factory of Sir H. Grubb, in Dublin, Ireland.

NEW ZEALAND INSTITUTE.

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND INTITULED THE NEW ZEALAND INSTITUTE ACT, 1867; RECONSTITUTED BY AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND UNDER THE NEW ZEALAND INSTITUTE ACT, 1903, AND CONTINUED BY THE NEW ZEALAND INSTITUTE ACT, 1908.

Board of Governors.

EX OFFICIO.

His Excellency the Governor.
The Hon. the Minister of Internal Affairs.

NOMINATED BY THE GOVERNMENT.

Charles A. Ewen (December, 1912); A. H. Turnbull (December, 1912); Dr. J. Allan Thomson (December, 1913); Professor G. W. von Zedlitz, M.A. (December, 1913).

ELECTED BY AFFILIATED SOCIETIES (DECEMBER, 1913).

Wellington Philosophical Society ...	Professor T. H. Easterfield, M.A., Ph.D. Professor H. B. Kirk, M.A.
Auckland Institute	D. Petrie, M.A., Ph.D. Professor H. W. Segar, M.A.
Philosophical Institute of Canterbury...	C. Coleridge Farr, D.Sc. R. Speight, M.A., M.Sc., F.G.S.
Otago Institute	Professor Marshall, D.Sc., F.G.S. G. M. Thomson, F.C.S.
Hawke's Bay Philosophical Institute ...	H. Hill, B.A., F.G.S.
Nelson Institute	L. Cockayne, Ph.D., F.L.S., F.R.S.
Manawatu Philosophical Society ...	K. Wilson, M.A.
Wanganui Philosophical Society ...	Dr. H. R. Hatherly, M.R.C.S.

OFFICERS FOR THE YEAR 1915.

President: D. Petrie, M.A., Ph.D.
Hon. Treasurer: C. A. Ewen.
Hon. Editor: C. Chilton, D.Sc., M.A., M.B., LL.D., F.L.S.
Secretary: B. C. Aston, F.I.C., F.C.S.
(Box 40, Post-office, Wellington.

AFFILIATED SOCIETIES.

Name of Society.	Secretary's Name and Address.	Date of Affiliation.
Wellington Philosophical Society	A. C. Gifford, 6 Shannon Street	10th June, 1868.
Auckland Institute ..	T. F. Cheeseman, Museum ..	10th June, 1868.
Philosophical Institute of Canterbury	A. M. Wright, Box 617, Christchurch	22nd October, 1868.
Otago Institute	E. J. Parr, Boys' High School ..	18th October, 1869.
Hawke's Bay Philosophical Institute	James Niven, Technical College	31st March, 1875.
Nelson Institute	E. L. Morley, Waimea Street ..	20th December, 1883.
Manawatu Philosophical Society	K. Wilson, Palmerston North ..	6th January, 1905.
Wanganui Philosophical Society	J. P. Williamson	2nd December, 1911.

FORMER HONORARY MEMBERS.

1870.

Agassiz, Professor Louis.
Drury, Captain Byron, R.N.
Flower, Professor W. H., F.R.S.
Hochstetter, Dr. Ferdinand von.
Hooker, Sir J. D., G.C.S.I., C.B., M.D., F.R.S., O.M.
Mueller, Ferdinand von, M.D., F.R.S., C.M.G.
Owen, Professor Richard, F.R.S.
Richards, Rear-Admiral G. H.

1871.

Darwin, Charles, M.A., F.R.S.
Gray, J. E., Ph.D., F.R.S.
Lindsay, W. Lauder, M.D., F.R.S.E.

1872.

Grey, Sir George, K.C.B.
Huxley, Thomas H., LL.D., F.R.S.
Stokes, Vice-Admiral J. L.

1873.

Bowen, Sir George Ferguson, G.C.M.G.
Günther, A., M.D., M.A., Ph.D., F.R.S.
Lyell, Sir Charles, Bart., D.C.L., F.R.S.

1874.

McLachlan, Robert, F.L.S.
Newton, Alfred, F.R.S.
Thomson, Professor Wyville, F.R.S.

1875.

Filhol, Dr. H.
Rolleston, Professor G., M.D., F.R.S.
Sclater, P. L., M.A., Ph.D., F.R.S.

1876.

Clarke, Rev. W. B., M.A., F.R.S.
Etheridge, Professor R., F.R.S.

1877.

Baird, Professor Spencer F.
Weld, Frederick A., C.M.G.

1878.

Garrod, Professor A. H., F.R.S.
Müller, Professor Max, F.R.S.
Tenison-Woods, Rev. J. E., F.L.S.

1880.

The Most Noble the Marquis of Normanby, G.C.M.G.

1883.

Carpenter, Dr. W. B., C.B., F.R.S.
Ellery, Robert L. J., F.R.S.
Thomson, Sir William, F.R.S.

1885.

Gray, Professor Asa.
Sharp, Richard Bowdler, M.A., F.R.S.
Wallace, A. R., F.R.S., O.M.

1888.

Beneden, Professor J. P. van.
Ettingshausen, Baron von.
McCoy, Professor F., D.Sc., C.M.G. F.R.S.

1890.

Riley, Professor C. V.

1891.

Davis, J. W., F.G.S., F.L.S.

1895.
Mitten, William, F.R.S.

1896.
Langley, S. P.

1900.
Agardh, Dr. J. G. | **Avebury, Lord, P.C., F.R.S.**

1901.
Eve, H. W., M.A. | **Howes, G. B., LL.D., F.R.S.**

1906.
Milne, J., F.R.S.

1909.
Darwin, Sir George, F.R.S.

FORMER MANAGER AND EDITOR.

[Under the New Zealand Institute Act, 1867.]

1867–1903.
Hector, Sir James, M.D., K.C.M.G., F.R.S.

PAST PRESIDENTS.

1903–4.
Hutton, Captain Frederick Wollaston, F.R.S.

1905–6.
Hector, Sir James, M.D., K.C.M.G., F.R.S.

1907–8.
Thomson, George Malcolm, F.L.S., F.C.S.

1909–10.
Hamilton, A.

1911–12.
Cheeseman, T. F., F.L.S., F.Z.S.

1913–14.
Chilton, C., M.A., D.Sc., LL.D., F.L.S.

HONORARY MEMBERS.

1870.
Finsch, Professor Otto, Ph.D., Braunschweig, Germany

1873.
Pickard-Cambridge, The Rev. O., M.A., C.M.Z.S.

1876

BERGGREN, Dr. S., Lund, Sweden.

1877.

SHARP, Dr. D., University Museum, Cambridge.

1890.

LIVERSIDGE, Professor A., M.A., F.R.S., Fieldhead, Coombe Warren, Kingston Hill, England.

NORDSTEDT, Professor OTTO, Ph.D., University of Lund, Sweden.

1891.

GOODALE, Professor G. L., M.D., LL.D., Harvard University, Massachusetts, U.S.A.

1894.

CODRINGTON, Rev. R. H., D.D., Wadhurst Rectory, Sussex, England.

THISELTON-DYER, Sir W. T., K.C.M.G., C.I.E., LL.D., M.A., F.R.S., Royal Gardens, Kew.

1896.

LYDEKKER, RICHARD, B.A., F.R.S., British Museum, South Kensington.

1900.

MASSEE, GEORGE, F.L.S., F.R.M.S., Royal Botanic Gardens, Kew.

1901.

VON GOEBEL, Professor Dr. CARL, University of Munich.

1902.

SARS, Professor G. O., University of Christiania, Norway.

1903.

KLOTZ, Professor OTTO J., 437 Albert Street, Ottawa, Canada.

1904.

RUTHERFORD, Professor Sir E., D.Sc., F.R.S., University of Manchester.

DAVID, Professor T. EDGEWORTH, F.R.S., C.M.G., Sydney University, N.S.W.

1906.

BEDDARD, F. E., F.R.S., Zoological Society, London.

BRADY, G. S., F.R.S., University of Durham, England.

1907.

DENDY, Dr., F.R.S., King's College, University of London, England.

DIELS, Professor L., Ph.D., University of Marburg.

MEYRICK, E., B.A., F.R.S., Marlborough College, England.

STEBBING, Rev. T. R. R., F.R.S., Tunbridge Wells, England.

1910.

BRUCE, Dr. W. S., Edinburgh.

1913.

DAVIS, Professor W. MORRIS, Harvard University.

HEMSLEY, W. BOTTING, England.

1914.

ARBER, Dr. E. NEWELL, Cambridge, Eng.

BALFOUR, Professor J. BAYLEY, F.R.S., Royal Botanic Gardens, Edinburgh.

HASWELL, Professor W. A., F.R.S, University, Sydney.

1915.

BATESON, Professor W., F.R.S., England.

ORDINARY MEMBERS.

WELLINGTON PHILOSOPHICAL SOCIETY.

[* Life members. † Honorary members.]

Acland, E. W., P.O. Box 928, Wellington
Adams, C. E., D.Sc., A.I.A. (London), F.R.A.S., Hector Observatory, Wellington
Adams, C. W., Bellevue Road, Lower Hutt
Adamson, Professor J., Victoria College, Wellington
Adkin, G. L., Queen Street, Levin
Alabaster, A. H., care of District Engineer, Railways, Wellington
Anderson, W. J., M.A., LL.D., Education Department, Wellington
Aston, B. C., F.I.C., F.C.S., Dominion Laboratory, Wellington
Atkins, A., F.R.I.B.A., Assoc.M. Inst.C.E., Grey Street, Wellington
Atkinson, E. H., Agricultural Department, Wellington
Bagley, G., Young's Chemical Company, 14 Egmont Street, Wellington
Bakewell, F. H., M.A., Education Board, Mercer Street, Wellington
Baldwin, E. S., 215 Lambton Quay, Wellington
Bates, Rev. D. C., Weather Office, Wellington.
Beere, W. C., 155 Featherston Street, Wellington
Beetham, W. H., Masterton
Begg, Dr. C. M., 164 Willis Street, Wellington
Bell, E. D., Panama Street, Wellington
Bell, Hon. Sir H. D., K.C., B.A., Panama Street, Wellington
Berry, C. G. G., 35 Bolton Street, Wellington
Blair, David K., M.I.Mech.E., 9 Grey Street, Wellington
Blake, V., District Lands and Survey Office, Wellington
Blow, H. J. H., Public Works Department, Wellington
Brandon, A. de B., B.A., Featherston Street, Wellington
Bridges, G. G., 2 Wesley Road, Wellington
Broadgate, F. L. K., B.Sc., Dominion Museum, Wellington
Browne, M. H., Education Department
Burnett, J., M.Inst.C.E., Head Office, Railways
Campbell, J., F.R.I.B.A., Public Works Department, Wellington
Carter, F. J., M.A., Diocesan Office, Wellington
Carter, W. H., care of Dr. Henry, The Terrace, Wellington
Chapman, Martin, K.C., Brandon Street, Wellington
Chudleigh, E. R., Orongomairoa, Waihou
Cockayne, Dr. L., F.R.S., 13 Colombo Street, Wellington
Cook, H. D., M.Sc., B.E. (Elect.), Bank Chambers, Lambton Quay, Wellington
Cotton, C. A., D.Sc., Victoria College, Wellington
Crawford, A. D., Box 126, G.P.O., Wellington
Crawford, Miss Grace A., Box 813, G.P.O., Wellington
Crewes, Rev. J., 90 Owen Street, Wellington
Dougall, Archibald, 34 Austin Street, Wellington
Dymock, E. R., A.I.A.N.Z., Woodward Street, Wellington
Earnshaw, W., 4 Watson Street, Wellington
Easterfield, Professor T. H., M.A., Ph.D., Victoria College, Wellington
Ewen, C. A., 126 The Terrace, Wellington
Ferguson, William, M.A., M.Inst. C.E., M.Inst.Mech.E., 131 Coromandel Street, Wellington

Field, W. H., 160 Featherston Street, Wellington
FitzGerald, Gerald, A.M.Inst.C.E., Government Insurance Building, Wellington
Fleming, T. R., M.A., LL.B., Education Board Office, Wellington
Fletcher, Rev. H. J., The Manse, Taupo
Fox, T. O., Borough Engineer, Miramar, Wellington
Fraser, G. V. R., Railway Buildings, Wellington
Freeman, C. J., Webb Street, Wellington*
Freyberg, C., Macdonald Crescent
Fulton, J., 14 North Terrace, Kelburne
Furkert, F. W., M.Inst.C.E., Public Works Department, Wellington
Garrow, Professor J. M. E., B.A., LL.B., Victoria College, Wellington*
Gavin, W. H., Public Works Department, Wellington
Gibbs, A., Telegraph Department, Wellington
Gibbs, Dr. H. E., 240 Willis Street, Wellington
Gibson, Miss G. F., M.A., 10 Hill Street, Wellington
Gibson, W., B.E. (Mining), Geological Survey Department, Wellington
Gifford, A. C., M.A., 6 Shannon Street, Wellington*
Girdlestone, H. E., Lands and Survey Department, Wellington
Gottfried, Rev. I. von, Boulcott Street, Wellington
Goudie, H. A., Whakarewarewa
Haast, H. F. von, M.A., LL.B., 41 Salamanca Road, Wellington
Hamilton, H., 58 Bowen Street, Wellington
Hanify, H. P., 18 Panama Street, Wellington
Harding, R. Coupland, 63 Matai Road, Haitaitai*
Hastie, Miss J. A., care of Street and Co., 30 Cornhill, London, E.C.*
Hayward, Captain J. A., 113 Tasman Street, Wellington
Hector, Barclay, Lower Hutt
Hector, Dr. C. Monro., M.D., B.Sc., Lower Hutt
Helyer, Miss E., 13 Tonks Grove, Wellington
Henderson, J., M.A., D.Sc., B.Sc. in Engineering (Metall.), Geological Survey Department, Wellington
Hislop, J., Department of Internal Affairs, Wellington
Hodson, W. H., 40 Pirie Street, Wellington
Hogben, G., M.A., F.G.S., C.M.G., Education Department, Wellington
Holmes, R. L., F.R.Met.S., Kaiora, Fern Street, Randwick, Sydney*
Holmes, R. W., M.Inst.C.E., Public Works Department, Wellington
Hooper, Captain G. S., Grant Road North, Wellington
Hudson, G. V., F.E.S., Inspector's Office, G.P.O., Wellington
Humphries, Thomas, Laery Street, Lower Hutt
Hursthouse, E. W., Routh's Buildings, Wellington
Isaac, E. C., Education Department, Wellington
Jack, J. W., Featherston Street, Wellington
James, L. G., 31 Hunter Street, Wellington
Jenkinson, S. H., Railway Buildings, Wellington
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